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Technical Men Direct Foundry

Motor Castings Made In New Shop Equipped with Conveyors and Cranes for Continuous Pouring—Cores for Cylinder Castings Assembled in Core Room Are Set as a Unit in the Drag

BY H. E. DILLER

PROGRESS with its attendant change permeating all modern endeavor is seen in many phases of the foundry work, each year bringing some new evolution in one or more branches of the industry. The sum of increasing changes in the process of making castings has invoked a large amount of complicated equipment so that now the superintendent of a foundry must understand considerable about the operation of machinery. Also, the practice, followed in some foundries, of mixing iron by analysis and operating the cupola continuously from early morning until the foundry closes at night requires a high degree of metallurgical knowledge. Thus some companies are beginning to think that a different kind of training is necessary from that formerly received by foundry executives; a technical education supplemented by practical experience being held by some to be a great advantage to a foundry superintendent.

A shop operated by the engineer who assisted in designing it therefore is a new departure of great interest, especially where a number of heads of departments are college graduates with only a few years of prac-

FIG. 1—A CIRCULAR APRON CONVEYOR, OR CARROUSEL, CARRIES MOLDS FROM FOUR MACHINES, TWO INSIDE AND TWO OUTSIDE THE CIRCLE—THE MOLDS ARE POURED WHILE ON THE CONVEYOR AND DUMPED BEFORE THEY AGAIN REACH THE MACHINES

tical training. This is the case of the foundry of the Lycoming Motors Corp., set among the hills of central Pennsylvania in the heart of Williamsport, once known as the Lumber city. At that time many saw mills were located in Williamsport and formed the nucleus of the city's industry but these gradually have been replaced until now none remain. In their place are other industries, the manufacture of sewing machines by the Demerest Mfg. Co., being one of the first industries in the city to require the services of a foundry. Later this company was acquired by the Lycoming Motors Corp. which recently has built a modern foundry to produce castings for the gasoline motor which it manufactures and to supply automobile castings to other manufacturers.

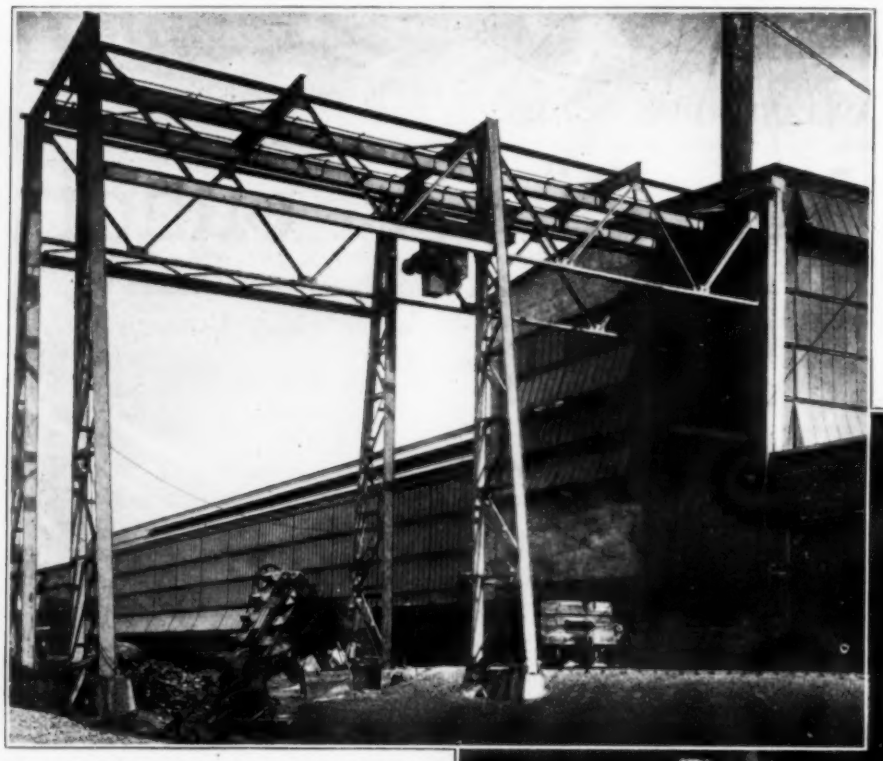


FIG. 2—METAL AND COKE ARE TAKEN TO THE CHARGING FLOOR BY A MONORAIL CRANE

Before considering the organization, it will be well to get an idea of the equipment and layout of the plant situated on a 17-acre plot at the foot of Park street, and connected with the Pennsylvania and the Philadelphia & Reading railroads, and by the latter with the Lehigh Valley and the New York Central roads. Shipping facilities are ample and, located in the center of an iron and coal district, raw materials are easily available.

The shop is built of steel frame with concrete, tile and steel sash. An idea of the extent to which steel sash are used may be obtained from Fig. 2, which gives a view of a portion of one side of the building. The main building containing the molding, and cleaning departments, shown in Fig. 4, is 150 x 480 feet. The core room is on the lower side of this main section extending along its entire length at a width of 40 feet. East of this section is the 50 x 240 foot office building which besides containing the general offices also houses the patternshop, the first aid room and the wash rooms for men and for women.

A monitor section located between the office building and the molding department serves as a stock bay and cupola charging department. One month's supply of pig iron is kept in the yard for emergency. Pig iron and coke which are bought on commitment are sent to the charging platform as received. Pig iron is received in open-top cars and placed under the monorail shown extending from the building in Fig. 2. From here it is carried by a magnet to bins on the charging floor. Scrap and spruce also are handled in the same way, being brought from the cleaning room at the opposite end of the building in cars. A locomotive crane equipped with a magnet is used for handling pig iron and scrap in the yard.

Coke is brought in dump cars and dropped into a hopper under the tracks. From this it is raised by a bucket elevator which discharges upon a horizontal belt conveyor extending over a series of bins above the charging floor. The coke is delivered into any bin, as desired, by trippers conveniently arranged. Coke then can be secured on the charging floor by opening gates on chutes under the bins. These bins and chutes may be noted in the upper center of Fig. 5 which shows the bins for the pig iron and scrap at the right and the cupolas at the left. At present the iron is charged by hand, but plans are being worked out for mechanical charging. As may be noted, the bins for the pig iron and scrap are numbered so that a record is kept of the iron in the different bins and the chemist in making up the charges for the day may specify from which bin the metal is to be taken.

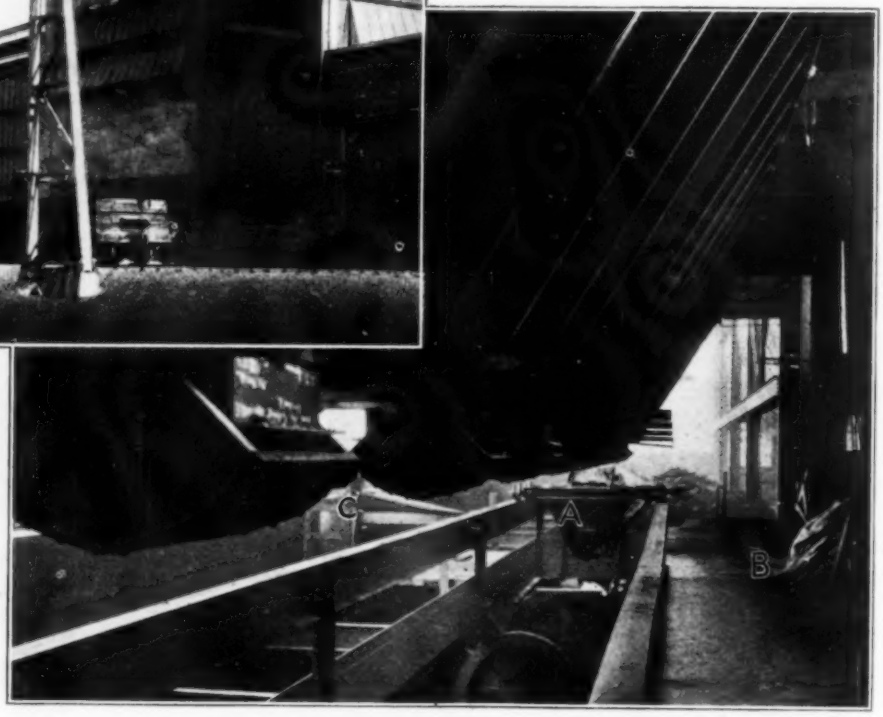


FIG. 3—SAND IS STORED IN STEEL HOPPERS AND DROPPED INTO A BUCKET WHICH, TRAVELING ON A TRACK BENEATH, CARRIES IT TO THE MIXER

Two mixtures are used as a rule, the one for cylinders, pistons and other castings requiring a close grained iron, and the other for the general run of castings in which a softer iron

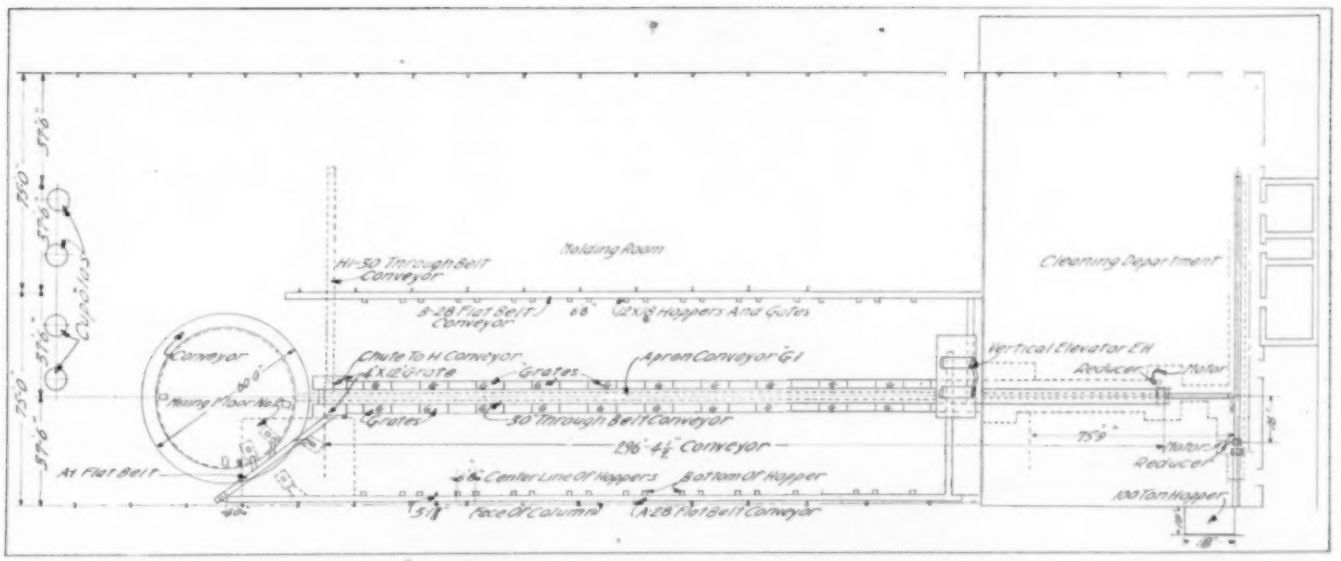


FIG. 4—ONLY ONE SIDE OF THE SHOP HAS BEEN EQUIPPED WITH CONVEYORS, AS SHOWN IN THE PLAN—MOLDS ARE DUMPED ON GRATINGS THROUGH WHICH THE SAND FALLS AND IS CARRIED TO STORAGE BINS—CASTINGS ARE SET ON THE CENTRAL APRON CONVEYOR

may be used with success. Fifteen per cent of steel scrap is used in the cylinder iron mixture as is also about 25 per cent of charcoal iron.

When the foundry first started it was the custom to melt both mixtures in the same cupola dividing them by a double layer of coke. Thus the slower melting at this point gave indications of the change of metal which also could be distinguished by the character of the spark given off. But even then it was impossible to divide the two mixtures entirely, so care was taken to use the last iron of the one mixture and the beginning of the next in castings in which it was not essential that the character of the iron be definite.

However, when the foundry was put on full operation each mixture of metal was melted in a separate cupola of which four have been provided by the Whiting Corp., Harvey, Ill. Thus two can be used one day and the other two the next. This is desirable as melting starts at 7:30 in the morning and continues all day. With such operation little opportunity would be had to repair the lining if a heat were taken from each cupola every day. Of the four cupolas, two melt 6 tons an hour and two melt 7 tons an hour. The air is supplied by blowers of the positive pressure type, made by the P. H. & F. M. Roots Co., Connersville, Ind.

In such a foundry operating continuously, sand handling is a considerable problem. Conveyor systems are used extensively for this purpose and also for pouring and handling castings. These systems were installed by the Lamson Co., Boston.

Core sand is brought into the building on the side directly opposite to where the pig iron and coke are introduced. It is handled from freight cars to storage bins, and from storage bins to mixing bins by a clamshell bucket, running on the same monorail system that takes care of the pig iron and scrap. As the sand is wanted it is dropped into a car on a narrow gage track by opening a gate on the bottom of the hopper. This car, shown at *A*, Fig. 3, travels over a sand mixer shown underneath it, which was supplied by the Standard Sand & Machine Co., Cleveland. Either dry compound is added to form the binder from the station marked *B*, or oil is drawn from the pump dimly noted at *C*. In one of the mixtures both dry binder and oil are used. The sand from the mixer is dropped into a hand push car traveling on a narrow gage track on a platform reaching the length of the core room. From this car it is dumped into chutes above the coremakers' benches. The one attendant is able to keep these chutes filled so that the coremakers are never without sufficient sand for their work.

The system of conveyors for handling the molding sand and castings may be understood better by referring to Fig. 1. This shows at the left hand end a carrousel serving four molding machines. This carrousel, which was designed by the Lamson Co., consists of a circular apron conveyor 60 feet in diameter and traveling at the rate of 1.8 feet per minute in a clockwise direction. Thus the molds which are put on the conveyor from the molding machines are closed and poured before they have traveled half around the circle. Ample time is allowed for the metal to solidify before the molds are dumped. Castings are shaken out on the gratings on both sides of the straight-line apron conveyor extending along the center of the south half of the shop.

FIG. 5—COKE IS STORED IN HOPPERS ABOVE THE CHARGING FLOOR AND PIG IRON IS KEPT IN BINS SHOWN AT THE RIGHT

Similar gratings are placed on both

sides of this conveyor along its entire length and molds from the floors on each side are dumped on the nearest grating. When a mold is dumped, the casting is pushed on the apron conveyor and carried by it to the cleaning department. The sand falls through the grating to a 30-inch trough-belt conveyor and is carried below the floor level to the end of the shop. The discharging end of the belt runs over a magnetic pulley, at which point all magnetic material is removed. The sand is then elevated by a bucket conveyor to the revolving screen overhead; discharging through the screen into a 100-ton storage hopper. Three pan conveyors, depending on the tonnage desired, feed the sand from these storage hoppers to the belts, which supply the molders. The tempering is done at the discharging end of each pan conveyor by means of atomizing sprays. The new sand is fed into the system at the rate of about 10 per cent per day, through the grates on the floor level at any place along the apron conveyor. Excess sand drops from the end of the conveyor into a chute which delivers it to the used-sand conveyor. The conveyor on the opposite side of the bay delivers excess sand to a cross conveyor which similarly dumps it into a chute which carries it to the used-sand conveyor.

With all these conveyors in operation a close system of control naturally is required so that if one is stopped another does not continue delivering sand and clog the system. For this purpose a system of switches has been arranged in a tower at the end of the shop so that the operator can control any conveyor in the system from this central station. Red lights indicate that the different conveyors are working; so in case any light is not burning the operator knows that a certain conveyor is not operating. A patrolman is kept constantly traveling over the system to look for irregular conditions, paying particular attention to the bearings to satisfy himself that there is no danger of overheating and burning out a bearing. In case he wishes to stop a conveyor he pulls any one of a great number of cords scattered along the system and attached to a whistle. The blowing of the whistle serves as a notice to the operator in the tower who immediately stops the entire system.

Besides the two men referred to, a man is employed to supervise the tempering of the sand for the molders' use, this sand being discharged from the belt, previously described, to hoppers over the molding machines by hand plows, which deflect the sand into the hoppers. When the hopper is filled the sand falls into an overflow box and works a cam which frees the tripper and allows the sand to pass along the conveyor. Thus the molders at all times have access to sand by opening the gates under the hoppers on their respective floors.

Arrangements also are made so that the molders do not have to pour the iron. Thus, with sand convenient and no pouring or shaking out of molds, the individual molder is able to put up a large number of molds a day. Metal is brought from the cupolas in ladles carried on a 2-ton monorail crane, two of which handle all of the iron. The ladles either are set on stands at the end of the floor to be poured off with hand ladles or they are carried over the molds by cab operated bridge cranes. The shop is equipped with 10 of these cranes, two of which operate over the carrousel. Fig. 10 illustrates the device used to hold a pouring funnel when the large ladle is employed for pouring the smaller molds. This consists of a frame of angle and bar iron. Two feet at one end are equipped with wheels while the other end is provided with a cross bar which serves as a handle

FIG. 6—DRAGS FOR CYLINDER CASTINGS ARE MADE ON A JAR-RAM ROLLOVER DRAW MACHINE

FIG. 7—CORES FOR CYLINDER CASTINGS ARE ASSEMBLED IN A TEMPLET AND PASTED AND LEADED TOGETHER

for raising the feet from the ground and to draw the device to the next mold.

The north side of the shop is not yet equipped with conveyors and continuous pouring has not been adopted here, but the molds which are mostly for crankcases are poured at the end of the day and dumped at night, the sand being cut with a sandcutter supplied by the American Foundry & Equipment Co., New York. The iron is handled in the same manner as on the other side of the foundry. An industrial track through the center of this section serves to convey the castings to the cleaning department.

FIG. 8—THE ASSEMBLED CORE SECTIONS ARE BOUND TOGETHER WITH STEEL RODS, *H*

Before considering the cleaning room it will be of interest to learn something about the molding methods. As has been said cylinder molds are made on four machines situated at the carrousel—two inside and two outside of the conveyor. These machines are of the jar-ram, rollover, pattern-draw type made by the Osborn Mfg. Co., Cleveland. Two molders work on each machine. The flask is coated with clay wash, set on the pattern and clamped to the jarring table. Two small stop-off cores are set at the end of the pattern for the water jacket. The sand is allowed to fall into the mold from the overhead chute and jolt rammed. The edges also are rammed with an air rammer and after the bottom board has been attached the mold is rolled over and the pattern drawn. The table on which the mold rests is swung to the side as shown in Fig. 6. The two molders lift the mold onto a stand to finish it and then dust blacking over the surface.

In this method of making cylinders the molding is extremely simple, as has been shown, no cope being required. However, great care and precision are necessary when forming the core which is made up of a number of small cores firmly joined together to set in place in the mold as a unit.

The finished core includes two head jacket cores, two side slabs, one chunk core which forms the spring housing openings, and one No. 2 jacket core, all made on six rollover machines furnished by the International Molding Machine Co., Chicago; also a cover slab and a top jacket core, the former made on one and the latter on two hand-jolt rollover machines manufactured by the Osborn Mfg. Co. A rollover machine made by Henry E. Pridmore, Chicago, is also used in making the No. 2 jacket cores. The barrel cores are made on a bench as are also the two single-exhaust cores, the double-exhaust core and the gas-intake core.

These cores are assembled in a templet to form a unit. Fig. 7 shows a side slab core, *D*, assembled with a jacket core and the intake and exhaust port cores hooked on. The jacket cores are well vented, then finished and piled conveniently for the workman who assembles them. The lead pot at the left is used to melt lead for leading the cores together.

A further stage in the assembly of the core is illustrated in Fig. 9 which shows the barrels assembled and the other cores in the proper position so that the other end slab and the chunk core, shown assembled in the foreground can be set. One of the side slabs may be noted at *F*, and the holes for the rods which fasten the side cores together may be seen in the ends of the barrel cores.

FIG. 9—AFTER THE END CORE AND CHUNK CORE, SHOWN IN THE FOREGROUND, ARE ASSEMBLED ANOTHER SIDE CORE WILL BE PUT ON THE FRONT AND THE WHOLE WILL BE BOUND TOGETHER BY STEEL TIE RODS

The assembled core is shown in Fig. 8 which illustrated, at *H*, shows the cover core is bound to the side cores by hooks tightened with wing nuts and connected to eyes in the side cores. The finishing coremakers put blacking paste on at the joints, tie the side slabs together through the cylinders as has been mentioned and hook the top slab to the side slabs, then rub down the latter to give a

FIG. 10—A FUNNEL IS CARRIED OVER THE MOLD TO DIRECT THE METAL

perfectly flat surface. The assembled core is set in the drag mold and held down with clamps.

Naturally with such a large number of cores to make, the core room is of vital importance to this company. It is equipped with many core-making machines of the types mentioned, and the coremakers' stations are fitted with compressed air hose. Thirty-eight coke-fired double-rack core ovens, extending in a line 360 feet long, are used. These ovens were built by the Foundry Equipment Co., Cleveland. They are arranged in two batteries of 13 ovens each and two batteries of 6 ovens each. The batteries of 13 ovens have fireboxes at each end while the other batteries have a firebox at one end only. Each battery has a main flue connected to the individual ovens by side flues. Dampers in the ovens allow of control of the temperature which is recorded by thermometers. The cores are baked on racks moved by battery lift trucks made by the Lakewood Engineering Co., Cleveland, and the Automatic Transportation Co., Buffalo. These also serve to carry the cores to the molding department.

Baking of cores is avoided in some cases notably that of the piston core which is made on the molding machine in green sand. The drag, of which the core is a part, is made on a rollover, pattern-draw, machine built by Henry E. Pridmore. As may be noted from the illustration, Fig. 13, the cores contain a number of indentations which must be formed with loose pieces in the pattern. These are connected with a lever, I, by which they are drawn after the mold is rammed. Then after the bottom board is placed on it the mold is rolled over, and the pattern is drawn and rolled back to its original position, as indicated in Fig. 13. The cope is made on a jar-ram, tripping-plate machine made by the Arcade Mfg. Co., Freeport, Ill. This is illustrated in Fig. 14 which shows the down

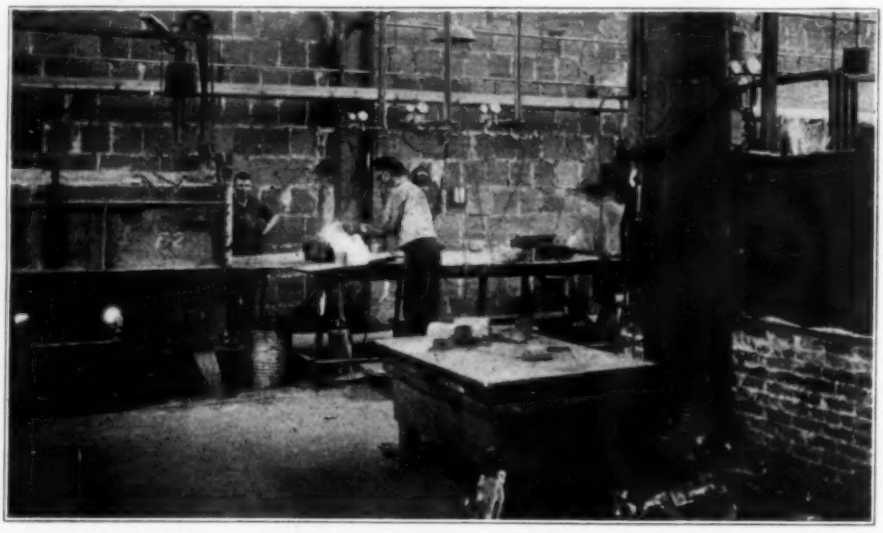


FIG. 12—WELDING IS DONE ON A TABLE BETWEEN TWO HEATING FURNACES

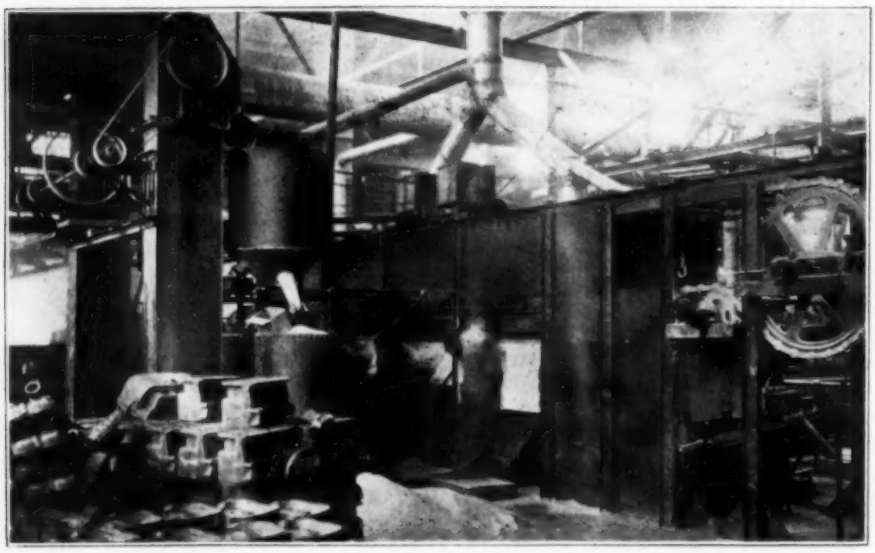


FIG. 11—CASTINGS ARE CARRIED THROUGH THE SAND-BLAST CABINET ON A CHAIN

gate connected to the center with a sprue. A strainer core is set in the central ring and, as may be noted, the pattern forms a small shrinkhead to trap any dirt which may be in the iron. Two runners are cut in the sand from the center gate to each of the pistons. The places at which they join may be noted on the mold.

Crankcases, as has been stated, are made on floors on the side of the foundry not given over to continuous pouring. They are jolted in steel flasks made by Truscon Steel Co., Youngstown, O., on rollover jar-ram machines furnished by the Osborn Mfg. Co. The usual complement of cores is used. One unique feature is the use of 8-inch square blocks in the center of the crankcase body core and in the bell-housing core. By the use of these blocks the amount of sand necessary is lessened with a decrease in cost and in the amount of core gas to be carried away. Also,

the core is more easily cleaned when the blocks are pulled out.

When the carrousel was first installed, flywheels were made on it. Fig. 1 shows the carrousel with the two machines located inside the circle, and the cupola in the background. The workmen may be noted pouring the molds on the far side of the conveyor.

The cleaning room at the end of the foundry building is fully equipped with tumbling barrels, sand-blast barrels and rooms, grinders and welding apparatus. To avoid confusion, marked aisles are maintained at all times. This gives free space for operating the tractor with its trailers built by the Mercury Mfg. Co., Chicago. The coupling on the trailers catches automatically when the truck strikes them and they are released by pressing a button on the side of the trailer.

The larger castings such as those for crankcases, cylinders, etc., are cleaned in a sand-blast cabinet through which they are carried, hooked to an endless chain. Three men on the side operate sand-blast nozzles, looking through screened slides to see the work, as shown in Fig. 11. The used sand falls on a belt which carries it to a bucket elevator that lifts it to a hopper. The hopper may be noted

FIG. 14—COPES FOR PISTONS ARE MADE ON A STRIPPING-PLATE MACHINE—NOTE IN THE MOLD THE GATE AT THE SIDE AND THE RING IN THE CENTER FOR A STRAINER CORE

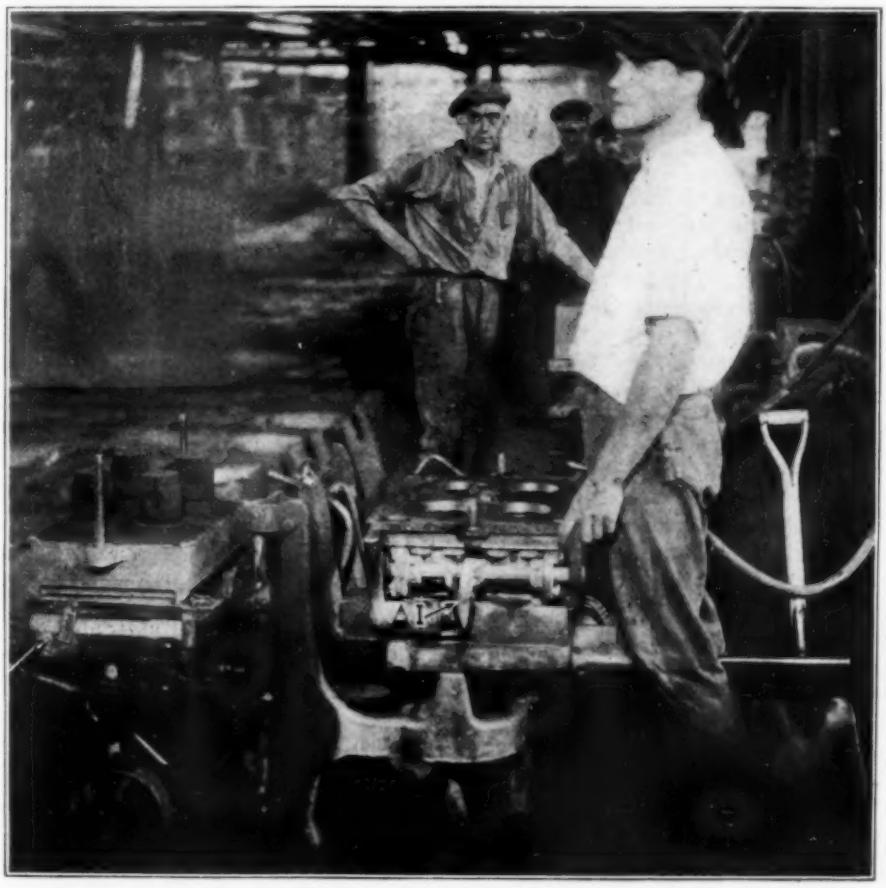


FIG. 13—PISTONS ARE MADE WITH GREEN-SAND—LOOSE PIECES ON THE PATTERN ALLOW IT TO BE DRAWN

at the side of the cabinet in Fig. 11. With this arrangement a continuous stream of castings is kept moving through the sand blast. This, together with a similar cabinet and two sand-blast barrels, two sand-blast tables and eight tumbling mills serve the present requirements of the shop. Dust is kept from the room by two dust arresters each connected with a large fan. Castings are snagged on 16 double-wheel grinding stands.

Like all modern automobile casting plants, the Lycoming shop is equipped with apparatus for welding castings. This includes two oil-fired heating furnaces through which the castings are pushed on rails. The two furnaces face each other with a welding bench between them as illustrated in Fig. 12. This bench is fitted with three oxy-acetylene welding torches. These together with the acetylene generating outfit, kept in a separate building, were supplied by the Davis-Bournonville Co., Jersey City, N. J. Castings are pulled from either furnace when they reach a uniform heat and are welded, then placed in the furnace back of the welders, shown at the side of the post at the extreme right, Fig. 12.

Another essential of the cleaning department is a set of hydraulic test-

ing stations for determining whether certain types of castings, especially cylinders, leak. A rigid inspection is given all such castings by the Lycoming company before the castings are sent to the machine shop at the main plant of the company, located about two miles from the foundry. The shipping platform, located on a spur of the railroad, may be noted at the upper right-hand corner of the plan shown in Fig. 4.

The plant is heated by two 250-horsepower boilers, and eight floor heaters made by the Skinner Bros. Mfg. Co., St. Louis. As has been stated this foundry is operated by young men. The chief executive officer of the foundry is barely past 30 years of age, while neither the foundry superintendent nor the master mechanic has reached this age. Two general departments divide the work. The operating department under the direction of the foundry superintendent takes care of the production of the castings and the engineering work is under the plant engineer.

As may be judged from the character of the shop with so many conveyors and other mechanical appliances, the engineering department has considerable scope. All operators of cranes and the workmen attending to the conveyors as well as the operators of trucks are under the direction of the plant engineer. Thus, if the operating department asks for a truck the driver is furnished with it.

The orders for castings being mostly of the repetition class for the company's own machine shop, the foundry superintendent is able to lay out his work a week in advance. Therefore, at the end of each week, when he receives a list of the number of castings wanted by the machine shop the following week, he makes out a schedule and sends it to all subforemen. This schedule goes into minute detail indicating the number of castings to be made each day from every pattern; also the time the blast is to be put on the cupola and the number of pounds of metal to be melted for every day in the week. Directions are given for maintaining the sand supply and the number of cores to be made are scheduled. Attention is called to details each foreman should watch, and responsibility for different steps is placed. Thus in one report a certain subforeman is made responsible for keeping the different operating departments supplied with men; another is directed to see that all flasks are placed in production as fast as they are delivered, etc. In this way the minutest details are covered and responsibility is placed with the various subforemen.

Of course, having a definite schedule, it is essential to determine whether it is being lived up to. To do this a composite report is made out every Thursday showing the total number of castings required from each pattern, and the number to be made each day of the week. In other columns are given the number of good castings made, and the number over or under the requirements made each day and the total shortage or surplus. A similar report covering the operations of the entire week is made out on Monday and when these reports show a slowing down on any pattern attention of the subforeman in charge of the particular floor is directed to the deficiency.

Reports on the number of defective castings and the causes of the defects are submitted regularly to the foundry superintendent who investigates cases which show an unduly high percentage of loss. As one precaution against poor iron, the chief chemist spends most of his time either at the cupola spout or on the charging floor, leaving the routine analysis to assistants.

Rigid inspection of the work at all stages is maintained under direction of the chief inspector of the company so that the production of the foundry must pass scrutiny of men not directly connected with the foundry organization. The inspectors, besides passing on the acceptability of the castings, decide whether defects in castings are due to the molder or coremaker, or must be paid for by the company.

Points Pitfalls in Cupola Operation

FUNDAMENTALLY melting iron in a cupola is a decidedly simple process said Pat Dwyer in opening his talk on cupola dyspepsia at the first fall meeting of the New England Foundrymen's association at the Exchange Club in Boston, Wednesday, Sept. 13. However, after making this statement Mr. Dwyer, who is engineering editor of THE FOUNDRY went on to show how many pitfalls might be encountered in the simple process.

One of the first difficulties which Mr. Dwyer pointed out is that of charging the cupola properly. It is only human nature for the man handling material all day to desire to conserve his energy as much as possible, and this leads to inaccuracy in the weights of the different materials which go to make up the cupola charge. It is common practice to load pig iron into barrows or buggies, and then to wheel them on to scales where the barrows are trimmed. The trimming operation means handling pig iron; taking it off the barrow when over-weight or off a stock pile when underweight, and toward the end of the day, if no one is watching, there is a strong temptation to use the barrow load as it is. To correct this difficulty some person in authority should stand near the scales whenever possible, and check up the loads as they are trimmed.

In the case of small cupolas, the error due to inaccurate charging not only bears a greater proportion to the total charge, but because of the nature of small cupolas, is apt to cause more trouble than in the case of larger units. To serve as a check in charging, it is well to have a mark or gauge to show the height of the different layers. Under normal conditions the coke bed, for instance, should extend about 30 inches above the tuyeres.

After charging, the method of ignition was given consideration. Mr. Dwyer outlined the various methods in use today, and cautioned against the use of a single torch in the case of large cupolas because of the one-sided ignition of the coke. Two torches diametrically opposed overcome this difficulty.

Foundry practice as a whole is less up-to-date and efficient than are operations in many other industrial plants. The practice of pouring at the end of the day after all the molds have been completed, is particularly bad according to Mr. Dwyer's belief. Continuous pouring throughout the day not only avoids the congestion and rush of the usual late afternoon pouring period, but makes it possible to secure the same production in a building of about one-fourth the floor area.

The remedies to the more obvious troubles in cupola operation can be summed up in greater care all along the line. Undoubtedly the foreman is a busy man, and if he could be every place at once, operations might run smoothly. As long as this is impossible, he must take steps to see that his assistants perform their jobs.

What Technical Schools Offer

Foundry Courses Undertaken Must Be Broadened To Give More Thorough Training—Questionnaire Sent To Many Institutions and the Replies when Tabulated Show Considerable Variation

BY J. D. HOFFMAN AND R. E. WENDT

APPLICATION of science to the industries in past years has been more or less voluntary on the part of the manufacturers of the country. The natural resources of this country have been so vast and so varied that great waste has occurred as a natural result of the process of wholesale elimination in selecting the best, and close refinements were not considered necessary. In recent years, however, the fact of the urgent need of the conservation of these natural resources has been so impressed upon the people that industries of all kinds are being reconstructed along lines of scientific and economic production.

One of the influences aiding this development toward economy has been and is the technical school. Here materials are analyzed, their physical properties charted and fundamental facts and laws established concerning them. The technical school has had for its aim the connecting up of the theoretical training in the sciences with the practical training in the drawing rooms, shops and power plants of the country, and the harmonizing of these two forces toward the one aim, solely, the development of a young manhood capable of assisting in this reconstruction and of being absorbed into the industries of the country with the least economic loss.

Whatever degree of progress has attended this educational scheme in the past, and we have reason to believe this progress has been marked, there still is great improvement to come. The theoretical work of the class room has been supplemented by physical experiment and research in the materials laboratories, and by the more practical work of the shops and drawing rooms in these institutions. However, with all the effort thus far expended the schools, chiefly because of lack of funds to maintain such work, have given only a small amount of study to the engineering features of shop and other manufacturing processes.

One of the most backward of these important lines is that of the foundry. In the manufacturing world, the foundry is the place where great losses may be incurred or great economies may be effected. In this regard it compares somewhat with the power plant of any institution where the first reductions from the potential heat value of the coal to the active heat of the steam may sustain greater losses than can possibly be made up by all the mechanical refinements in the succeeding processes. Although the tardy recognition of its importance in the field of manufacture has delayed the foundry industry probably more than other lines, it is now being studied commercially and is looking forward to a rapid scientific development.

Many letters have been addressed to the technical schools asking what the schools are doing to help out the situation. These letters naturally had to be answered in a general way only, because no comparative data were at hand. Therefore, in order to obtain first hand knowledge of what is being done by the technical schools in the line of foundry work a questionnaire shown in the accompanying illustration was sent to 71 technical schools asking for information. Out of these 50 were answered and returned. Of the 50 replying 30 operate foundries, 20 keep a partial record of work performed and only 10 keep a complete record as is shown in the tables.

The schools were arranged alphabet-

Paper presented at the Rochester convention of the American Foundrymen's association. The authors are associated with Purdue university, Lafayette, Ind.; J. D. Hoffman, as head of the department of practical mechanics, and R. E. Wendt as instructor of foundry practice.

Table I

Enrollment and Organization

School number	Number of students in foundry courses	Number hours in course	Hours to period	Number students to class	Number students to one instructor
1	61	45	3	20	20
2	570	36	2	32	..
3	109	60	3	20	8
4	..	90	2.5	26	13
5	283	144	4	40	14
6	250	72	3	26	13
7	150	54	3	20	20
8	110	51	3	20	20
9	200	48	3	20	20
10	505	60	3	72	20
11	162	..	4	23	8
12	61	36	3	22	22
13	40	37.5	2.5	20	20
14	40	45	3	24	24
15	109	80	4	18	18
16	100	64	4	20	20
17	132	72	3	22	22
18	598	96	4	60	15
19	60	20	.	10	10
20	120	50	3	8	8
21	100	33	3	28	28
22	108	60	2	30	20
23	87	72	3	25	25
24	12	80	4	12	12
25	358	45	3	37	19
26	36	54	.	24	24
27	25	..	4	13	13
28	120	..	3	18	18
29	87	108	3	20	20
30	150	32	2	20	20

Note:—Blank spaces indicate no report.

Table II

Equipment and Class of Work

School number	Metals Poured: Gray iron	Brass	Aluminum	Size cupola inches	Brass furnace	Maximum weight casting pounds
1		x	x	54	x	5
2	x	x	x	42 & 24	x	1200
3	x	x	x	24	x	700
4	x	x	x	20	x	600
5	x	x	x	24	x	990
6	x	x	x	30	x	1200
7	x	x	x	15 & 20	x	720
8	x	x	x	20	x	1100
9	x	x	x	18 & 27	x	1000
10	x	x	x	23	x	...
11	x	x	x	32	x	500
12	x	x	x	24	x	200
13	x	x	x	15		20
14	x	x		24	x	250
15	x	x	x	22	x	150
16		x	x	20	x	...
17	x	x	x	20	x	1000
18	x	x	x	24	x	200
19	x			22	x	500
20		x	x	..	x	60
21	x	x	x	28	x	1000
22	x	x	x	26	x	225
23	x	x	x	22	x	100
24	x	x	x	24	x	250
25	x	x	x	24	x	350
26	x			30		100
27	x	x	x	20	x	600
28	x	x	x	26		600
29	x	x	x	22	x	290
30	x	x	x	26	x	700

Note:—Blank spaces indicate no report.

Table III

Data on Results Secured in Schools

School number	No. of heats	Metal charged	Good castings	Bad castings	Metal in sprues	Surplus metal	Loss in melting	Melting ratio
*1	..	....	....	....	....	....	....	..
2	30	60,000	44,496	7,833	5,500	....	1,200	7
3	30	50,000	30,000	15,000	3,000	....	2,000	7.5
4	34	10,000	....	....	....	....	....	..
5	24	88,000	37,000	11,000	24,000	8,000	8,000	9
6	24	80,000	....	....	....	....	....	..
7	36	38,000	....	....	....	....	....	..
8	28	43,345	25,027	2,998	4,250	6,484	4,586	5.5
9	20	30,000	22,200	1,000	2,600	1,500	2,700	5.5
10	17	11,000	....	....	....	....	....	4
11	24	....	....	....	....	....	....	..
12	3	5,400	2,000	....	....	....	....	4
13	10	4,000	....	....	....	....	....	..
14	6	3,000	....	....	....	....	....	5
15	30	58,086	22,680	7,560	17,580	7,500	2,766	6.5
16	..	....	....	....	....	....	....	..
17	28	82,000	62,139	3,116	10,330	4,146	2,269	5.4
18	30	62,700	33,431	1,973	19,286	3,228	4,782	4.8
19	4	6,000	....	....	....	....	....	..
20	..	....	....	....	....	....	....	..
21	15	30,000	....	....	....	....	....	..
22	8	8,400	4,284	338	1,636	1,680	462	3
23	6	24,000	6,000	8,000	....	....	....	4
24	..	3,000	....	....	....	....	....	..
25	13	20,800	13,800	1,200	3,900	1,600	260	3.2
26	?	....	....	....	....	....	....	..
27	12	5,000	....	....	....	....	....	..
28	10	8,000	4,000	1,000	500	300	2,200	9
29	12	24,046	8,899	4,607	(8,599)		1,941	..
30	10	16,000	14,500	700	700	....	....	8

*Weights given in pounds.

ically, then numbered from 1 to 30, and listed in Table I. The 30 schools had a total enrollment of 4742 students in the foundry courses during the year 1920-21. The largest enrollment in any one school was 598 and the lowest was 12. The total length of time devoted to foundry work ranged from 20 to 144 hours. The students work from 2 to 4 hours in any one day and from 1 to 3 days per week. There were from 8 to 72 students working in one class and one instructor was employed on the average for every 18 students.

Table II shows the kind of castings made, size of cupolas used and the maximum weight of single castings. Most of the schools make gray-iron, brass and aluminum castings. Only one school reported steel castings.

The cupola furnaces used range in size from 15 to 54 inches on the inside of the lining. The 24-inch cupola seems to be the most popular for school work. For melting the nonferrous metals, almost all kinds of furnaces built to melt this metal are used except the electric furnace. However, some of the schools are planning the installation of electric furnaces as soon as their funds will permit. Small to medium sized castings are made by all the foundries, the sizes ranging from a few ounces to about 1200 pounds.

In Table III the performance records of the 30 schools operating foundries are shown. It may be noticed that five schools do not keep any record of their melt or performance, 15 have only a partial record and 10 keep a complete record. This seems to indicate that most of the schools are as yet not operating their foundries on a thoroughly scientific basis.

Table III also shows the number of heats taken during the year, the total metal charged by each school, the number of pounds of good and bad castings made, the amount of metal contained in sprues and risers, the surplus metal, the loss in melting and the melting ratio.

These data show a wide difference in the loss in melting and the melting ratio. It was thought that probably some did not understand the question, so considerable correspondence was carried on to ascertain whether or not this was true. The answers in every case were that they understood the question. However, the melting ratio seems to indicate that in many cases this was based on the iron and coke charged above the bed charge instead of the total metal melted to the total coke burned. A melting ratio of 3 to 1 seems to be pretty low and a melting ratio of 9 to 1 somewhat high for small cupolas and especially in small heats.

In Table IV the results obtained by the 10 schools keeping complete records are shown. The percentages are based on the total amount of metal charged. Here a wide variation in the results obtained is shown. One school reports as high as 75.8 per cent of good castings and one reports only 39.1 per cent. The bad castings show a wide difference. One

SCHOOL FOUNDRY DATA

Name of School ----------

Located at ----------

Type of School. Engineering. Trade.

How many students were enrolled in the foundry course last school year? ----------

What year students take foundry work? ----------

How many hours in the course? ----------

How many hours to the period? ----------

Largest number of students to any one class ----------

Number of students to one instructor ----------

Underline the type of castings made. Gray-iron. Steel. Brass. Aluminum.

What size cupola do you use? Dimension on the inside of cupola ----------

What other type furnace besides cupola do you use? ----------

How many heats were poured during last school year? ----------

Type of castings made ----------

Maximum size of castings made ----------

Total amount of metal melted during school year ----------

Total number of pounds good castings made ----------

Total number of pounds unfit castings made ----------

Number of pounds of iron in sprues, risers ----------

Surplus metal ----------

Loss in melting ----------

What melting ratio did you obtain? ----------

Do you prefer to employ practical men or college graduates as teachers?

Date ----------

By ----------

FACSIMILE OF QUESTIONNAIRE SENT TO TECHNICAL SCHOOLS

reports having only 3.1 per cent bad castings and one had as high as 13 per cent. The percentages of sprues and risers show that the highest ran as high as 30.8 and the lowest as low as only 6.2 per cent. The surplus metal ranges from 3.8 to 20 per cent. In the percentage of loss in melting there seems to be a great difference, ranging from only 1.2 to as high as 27.5 per cent. As we all know, a wide difference exists in melting losses, but the percentages reported seem to be questionable.

Table V shows the total number of pounds of good and bad castings made by the 10 foundries having complete records of their work. It also shows the percentages of good and bad castings made. These percentages are based on the total pounds of castings made.

The question, "Do you prefer to employ practical men or college graduates as teachers?" was answered by 34 schools. Practical men were preferred by 23, college graduates with practical foundry experience by eight and college graduates by three.

The question is often asked, "Does the technical school give a young man a training equivalent to that of an apprenticeship in a manufacturing plant?" It does not, but it can give him something which will be a valuable substitute. Take the foundry course, for example. Table I shows that the time allowed for such work varies in the respective schools from 20 to 144 hours. On the basis of an 8-hour day the maximum time would amount to but 18 working days service. This time will seem to the practical foundry man as far too short, and to this we all agree, but it must be remembered that a curriculum of four years, including as it does those subjects fundamentally important to engineering, is in itself too short for any man to master these subjects thoroughly. However he should acquire a working knowledge of the subjects, and in addition a mental control which will enable him to think things out to their logical conclusions and in time, to orginate and develop for himself.

Because of the fact that it is difficult to greatly increase the school time devoted to the mechanical processes, it is necessary to plan every shop assignment so that it will teach its own lesson. Speed is sacrificed to carefulness and accuracy, and the repetition of process merely to acquire skill of hand is sacrificed to variety. That is to say—when a process has been done intelligently and acceptably well, a new one is substituted bringing into effect entirely new educational ideas. By this method every minute may be made to count for the most in an educational way.

The importance now attaching to the foundry business brings to the schools a new problem—that of extending the work materially and including those engineering features that make for economic production. In connection with the practical work on the foundry floor, such as molding, coremaking and pouring, there is need of instruction and research along engineering lines such as planning and managing foundries, cupola studies by the aid of chemical analyses, economic production by the aid of molding machines, selection of cores and core sands and other problems of equal importance that are presenting themselves for solution. These advanced lines where established will probably have to be taken as special or optional courses by the junior and senior students.

The foundry problem is yet to be solved. The schools are beginning to work on it and developments are sure to come. Much more will be accomplished in this line when the foundries of the country appreciate the fact that the technical schools can and probably will send out men each year who are fundamentally qualified to assist them in their problems of reconstruction. What everybody needs just at this stage of the game is an exhibition of co-operative spirit. The foundries can do a much needed work in an advisory capacity, by keeping in touch with the work that is being done in these institutions and making suggestions for the drafting of courses and the administering of the work. On the other hand those men who teach the subject, in most cases, are men of considerable practical experience and would undoubtedly welcome any suggestions coming from reliable sources.

Table V

Weight and Percentage of Good and Bad Castings

School number	Total castings	Good castings	Bad castings	Per cent Good	Per cent Bad
3	45,000	30,000	15,000	66.6	33.4
5	48,000	37,000	11,000	77.0	23.0
8	28,025	25,027	2,998	89.3	10.7
9	23,200	22,200	1,000	95.7	4.3
15	30,240	22,680	7,560	75.0	25.0
17	65,255	62,139	3,116	95.2	4.8
18	35,404	33,431	1,973	94.4	5.6
22	4,622	4,284	338	92.7	7.3
25	15,000	13,800	1,200	92.0	8.0
28	5,000	4,000	1,000	80.0	20.0

Table IV

Percentages Based on Total Metal Charged

School number	Good castings	Bad castings	Sprues risers	Surplus metal	Loss in melting
3	60.0	30.0	6.0	...	4.0
5	42.0	12.5	27.3	9.1	9.1
8	57.7	6.9	9.8	15.0	10.6
9	74.0	3.3	8.7	5.0	9.0
15	39.1	13.0	30.2	12.9	4.8
17	75.8	3.8	12.6	5.0	2.8
18	53.4	3.1	30.8	5.1	7.6
22	51.0	4.0	19.5	20.0	5.5
25	66.5	5.8	18.8	7.7	1.2
28	50.0	12.5	6.2	3.8	27.5

Will Build Cast Iron Pipe Foundry

Work will be started at once on the first unit of the new plant of the McWane Cast Iron Pipe Co., North Birmingham, Ala. A site of 30 acres has been purchased. J. R. McWane, president, announces that he expects to have the first unit in operation in March, giving employment to upwards 150 men and producing small sized pipe, ranging from 1½ to 6-inch. The company is operating under lease at the plant of the Southern Pipe Foundry Co. Mr. McWane is on the executive board of the American Cast Iron Pipe Co. and for a long time was president.

Develop New Alloy

The Detroit Aero Metals Corp., Detroit, has recently started preliminary operations looking toward the development of a newly discovered nonferrous alloy, resembling aluminum, which will be made into castings, rolled, forged and drawn into commercial products. Dr. W. Lenardo Williams is president.

The Warren Foundry & Machine Co., Phillipsburg, N. J., has changed its name to the Warren Foundry & Pipe Co., the latter being regarded as a little more indicative of the character of the company's work.

FIG. 1

Fig. 1—Cellular eutectic steadite commonly found in irons with over 0.50 per cent phosphorus—Hard form containing 10 per cent phosphorus—Silicon, 1.75; sulphur, 0.1; phosphorus, 0.75; total carbon, 3.30 per cent—Etched with 10 per cent bromine in amyl alcohol—x 735 dia.

Fig. 2—Phosphorus-rich structure called noncellular steadite—Softer and seemingly less brittle than the cellular form—Found in irons with 0.5 per cent phosphorus or under—Etched with picric acid—x 600 dia.

FIG. 2

FIG. 3

Fig. 3—Copper is deposited along the graphite areas and on the ferrite areas when a sample is etched with Stead's reagent—x 100 dia.

Fig. 4—Hypoeutectoid iron containing about 0.7 per cent phosphorus—Note intensely black dentrites occurring simultaneously with steadite—The composition of these dentrites is not definitely known although they probably are phosphorus rich—Etched with Stead's reagent—x 100 dia.

FIG. 4

FIG. 5

Fig. 5—Phosphide constituent of steadite is deeply eaten out, the sample having been etched with U. S. P. tincture of iodine—x 750 dia.

Fig. 6—Hypoeutectoid iron—Note that the pearlite and ferrite have been attacked by the 10 per cent aqueous ammonium persulphate etching solution, but the steadite has been immune—x 100 dia.

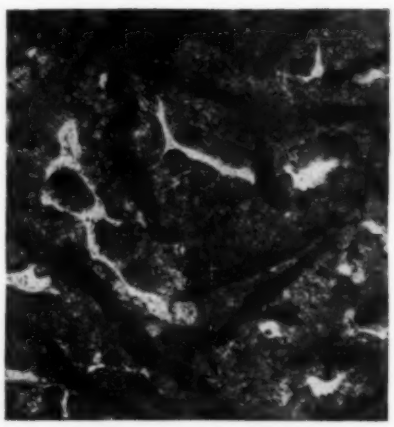


FIG. 6

FIG. 7

Fig. 7—Iron containing only traces of combined carbon and about 0.7 per cent phosphorus heat tinted to a general light brown which resolves itself into several colors when examined more closely—Ferrite is light brown; steadite white—x 100 dia.

Fig. 8—Steadite barely shows in relief in unetched sample of 0.35 per cent phosphorus cast iron—x 100 dia.

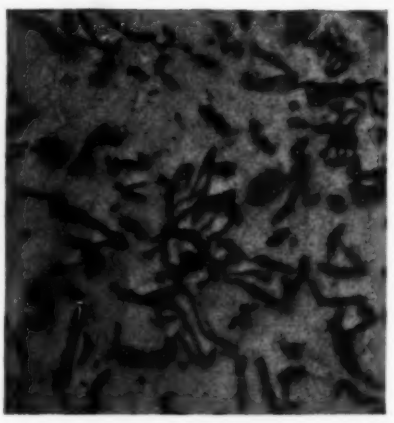


FIG. 8

Phosphorus Formations in Iron

Micrographs Indicate Existance of Phosphorus—Rich Alloys in Gray Iron—Theories on Effects of Phosphorus Net Work Are Contradicted and New Ideas Submitted—Etching Methods Outlined

BY J. W. BOLTON

IT IS the aim of this paper to show how phosphorus occurs in gray irons and semi-steels, and to point out what seem to be important practical facts concerning the actual functions of phosphorus in the metal. While the available existing information has been drawn upon freely this paper is presented neither as a complete exposition of the subject nor as a composite of the prevailing views on phosphorus in gray iron. Indeed, the latter is an impossibility, as many authorities differ on points of major interest.

In studying the effects of phosphorus, graphite, etc., in gray iron the microscope is an excellent tool. This fact has led some to herald metallic microscopy as the philosophers stone of the iron industry; with the inevitable reaction, condemnation of the microscope because it did not prove a cure all. It was the same story with chemical analysis—first scepticism; then a cure all; then condemned; then finally regarded properly as a useful tool, indispensable, but not a cure all or substitute for good common sense.

The four major structural components of ordinary gray iron are graphite pearlite, ferrite, and steadite. Graphite is largely free carbon. Pearlite is the eutectoid of ferrite and cementite, and in ordinary irons contains all the combined carbon. Ferrite is structurally pure iron. The term steadite as used in this article refers to the phosphorus-rich component in gray iron. In hard cast irons free cementite (iron carbide, Fe_3C) occurs. As explained in previous articles by the author, published in THE FOUNDRY of Jan. 15, Feb. 1 and June 1, 1922, each component may vary considerably in its ultimate composition, and the properties of the metal depend on the combined properties of its components.

Microscopy Detailed

Complete details in the miscroscopic study of the phosphorus structure in cast iron as given by the author in this article will no doubt prove of great value not only to the metallurgist beginning the microscopic study of iron, but to the more advanced student as Mr. Bolton presents original ideas along this line. Among these are proofs offered to show the existence of a series of phosphorus-rich alloys rather than the eutectic form in gray iron; and experimental contradiction of theories which have been advanced on phosphorus net work. He also illustrates the use of ammonium persulphate and of liquid bromine in amyl alcohol as etching reagents. The article will also prove of interest to foundrymen not entirely acquainted with metallography as it shows the different forms in which phosphorus exists in cast iron and how they are detected.

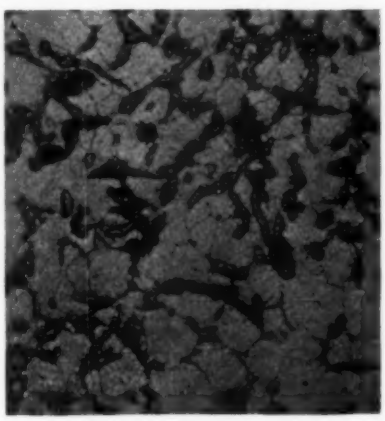


Fig. 9—Iron free from combined carbon; 0.35 per cent phosphorus—Note ferrite and small amount of steadite—Etched with picric acid—x 100 dia.

Iron-Phosphorus Alloys

According to the work of Dr. Stead, up to about 1.7 per cent phosphorus in carbonless iron occurs in solid solution, probably as the phosphide, Fe_3P, dissolved in iron. When present in amounts from 1.7 to 10.2 per cent the phosphor consists of a saturated solid solution and an eutectic alloy of Fe_3P and iron containing 10.2 per cent phosphorus. When the phosphorus amounts to 10.2 per cent the whole alloy is eutectic. This eutectic possesses a cellular or honeycomb structure like that shown in Fig. 1. With more than 10.2 per cent phosphorus the alloy is composed of the eutectic and crystals of Fe_3P, iron phosphide.

The steadite of hypoeutectoid gray iron is composed of one of these various binary (two phase) phosphide alloys, and not necessarily of the binary eutectic, either of iron and the Fe_3P phosphide, or possibly of iron and a series of phosphides of varying composition. In white cast iron, which contains free cementite a temary eutectic of iron—iron carbide—iron phosphide may be formed. The temary eutectic composition is about 1.9 per cent carbon, 6.9 per cent phosphorus, balance iron.

The experienced metallographist readily distinguishes steadite from ferrite and the other components of hypoeutectoid gray irons. At lower magnifications characteristic steadite is distinguished by its dendritic form and by its distribution. Ferrite most often occurs along the graphite flakes—see Figs. 11, 18, 19, showing dendritic forms and Figs. 9, 10 and 13, showing ferrite. At higher magnification steadite shows a more or less cellular structure while ferrite shows as polygonal grains as may be noted in Fig. 1.

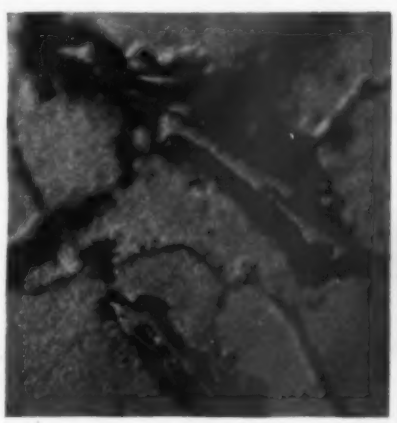


Fig. 10—Same sample as Fig. 9—Note small structureless form of steadite occurring along the ferrite grain boundries—Etched with picric acid—x 625 dia.

Fig. 11—*Sample from section* 8 *inches in diameter; combined carbon low; phosphorus* 0.60 *per cent—Note large grains of cellular steadite—x* 65 *dia.*

The two most widely advocated methods of distinguishing phosphorus rich forms in steel are by etching with Stead's reagent or by heat tinting (also originated by Stead). These methods have been applied to gray iron.

Stead's reagent is essentially a solution of cupric chloride in alcohol, acidified with hydrochloric acid. This reagent deposits copper, first on the portions low in phosphorus, then on portions successively richer in phosphorus. Where the phosphorus is very concentrated deposition of copper does not take place.

It is our experience that the electro deposition occurs first along the ferrite adjacent to graphite flakes, the parts containing the combined carbon being attached more slowly. Deposition of copper on an iron about 0.80 per cent combined carbon is slow. High, magnifications show copper deposited on the ferritic laminae of the pearlite. Ordinarily steadite is unattached. However, see Figs. 3 and 4. Fig. 3 shows distinct steadite dendrites. Higher magnification shows brownish color dots corresponding to the phosphite *cells* in the eutectic. It is quite probable that the evolution of hydrogen phosphide caused by action of the hydrochloric acid has resulted in precipitation of black or brown copper phosphide, which is insoluble in dilute hydrochloric acid. The writer offers no satisfactory explanation for the condition illustrated in Fig. 4.

Summing up, Stead's reagent does not deposit on phosphorus rich portions in iron and steel. Its value in gray iron metallography is quite limited. Steadite is easily distinquished by other more convenient methods. Under certain conditions Stead's reagent may produce a precipitate on phosphorus-rich portions which might be mistaken for a copper deposit, especially in micrographs where color values do not show.

In heat tinting the polished specimen is placed face up on a gas hot plate. Gradual heating produces a series of oxidation colors, from yellow, through red, blue, and finally back nearly to white. The various structural components of gray iron assume different colors as their rates of oxidation vary. For good results the writer immerses the specimen in 2 per cent phosphoric acid for a moment (no etching occurs) and then dries it carefully before placing it on the hot plate. Figs. 7 and 12 show heat tinting.

Heat tinting to dark brown with touches of purple develops purple along the edges of the steadite dentrites. The writer does not recommend heat tinting as a general method for identifying steadite in gray iron, unless it be for distinguishing it from cementite. The most valuable result from heat tinting is that it shows up the internal network of graphite. The appearance of light blue dots throughout the metal in high-sulphur irons is easily noticeable.

An alkaline solution of sodium picrate is widely used to distinguish free cementite from ferrite. The sample is immersed in a boiling solution for several minutes. Free cementite is colored black, while ferrite and pearlite are unattached. The steadite of

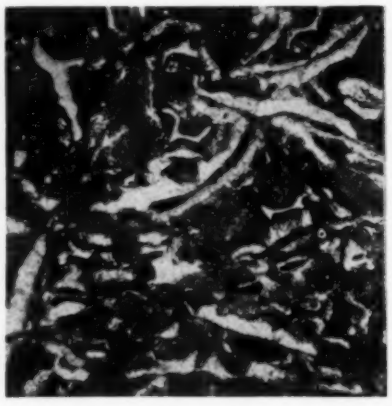


Fig 13—*Sample from heavy section of hypoeutectoid semisteel* (10 *per cent steel*) *casting;* 0.5 *per cent phosphorus —Note large size of steadite grains— Etched with picric acid—x* 44 *dia.*

Fig. 12—*Weak open-grain hypoeutectoid iron—phosphorus,* 0.7; *combined carbon,* 0.3 *per cent—Heat tinted to brown with purple in spots; pearlite with blue spots; ferrite light blue; steadite little affected—x* 100 *dia.*

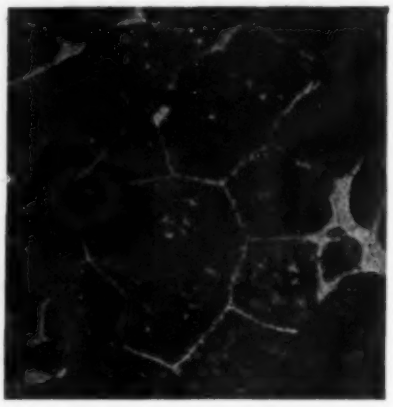


Fig. 14—*Iron with phosphorus* 0.35 *and combined carbon* 1.05 *per cent; heated to* 1975 *degrees Fahr. and quenched in oil—Note phosphorus-rich portion has melted and formed definite grain boundaries on cooling— Etched with picric acid—x* 300 *dia.*

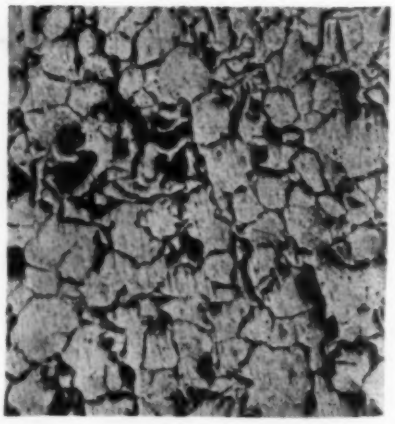


Fig. 15—*Same heat treatment as Fig.* 14 *and etched with alkaline sodium picrate—Note phosphorus-rich portion containing cementite is colored a deep black —Steadite in hypoeutectoid irons is not so easily colored by this etching reagent—x* 100 *dia.*

hypo-eutectoid gray irons is darkened somewhat, sometimes assuming a purplish color. The temary eutectic of phosphorus, cementite and iron is colored an intense black by alkali sodium picrate (Fig. 15). Ten per cent bromine in amyl alcohol is good to develop the cellular structure of binary steadite (Fig. 1). U. S. P. tincture of iodine also is satisfactory (Fig. 5).

Fairly concentrated nitric acid does not attack steadite as readily as it attacks pearlite and ferrite. This reagent is satisfactory for low powered examination, care being taken to have the ferrite etched until darkened. Because of its slow attack of ferrite it is not generally satisfactory.

Ammonium persulfate (10 per cent solution in water) is a valuable reagent for distinguishing steadite from ferrite at low magnifications. Ferrite and pearlite etched while steadite is not attacked, as indicated by Fig. 6. This

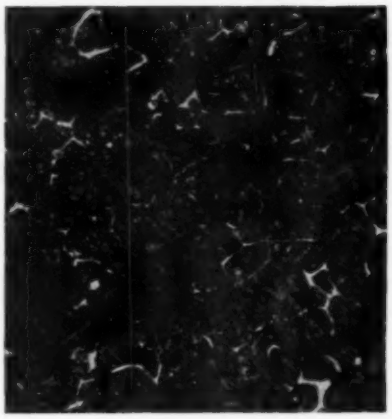


Fig. 16—Same sample and heat treatment as Fig. 15—Etched with picric acid—x 50 dia.

is the only reagent we have found which darkens ferrite and does not readily attack steadite.

Picric acid is the best all-round etching reagent. It develops the laminar structure of pearlite, the grain boundaries of ferrite, and the cellular form of steadite.

A general survey of present literature would indicate that phosphorus in gray iron occurs as the binary eutectic, 10.2 per cent phosphorus, in hypo-eutectic iron, and as the temary eutectic in hyper-eutectoid irons. Research work in this laboratory on steadite in hypo-eutectic gray irons shows that it does not always exist as a binary eutectic, but forms a series of phosphorus-rich alloys whose distribution and structure have much to do with the properties of gray iron and semisteel.

Fig. 17 represents an iron 1.15 per

Fig. 17—Hard machine-cast pig iron; phosphorus, 1.15; combined carbon, 0.60 per cent—Note cellular structure—Etched with picric acid—x 50 dia.

cent phosphorus and 0.60 per cent combined carbon which was hard to drill. Practically all the steadite in the sample is of the cellular eutectic form. Figs. 1 and 5 show dendrites from irons around 0.70 per cent phosphorus. In irons of this phosphorus content most of the steadite is of the cellular eutectic form. Figs. 2 and 20*D* show forms of steadite dendrite characteristic of irons under 0.50 per cent phosphorus. Fig. 22 shows a dendrite from an iron with only 0.17 per cent phosphorus.

Consideration of those examples, typical of a large number, examined by the author, of various analyses and manufactures, shows that steadite in commercial gray irons exists as a *series of phosphorus-rich alloys* rather than as the definite cellular eutectic alloy 10.2 per cent phosphorus. A most important conclusion to be derived from this is that the properties of the metal do not change exactly with the

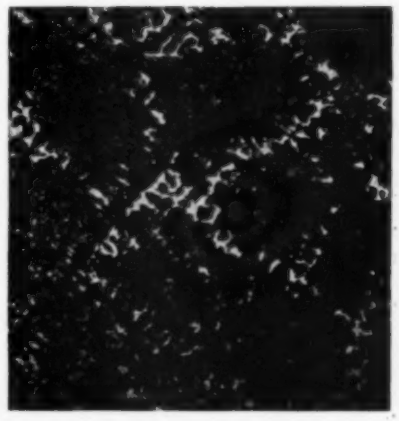


Fig. 18—Micrograph showing steadite grain boundaries—Etched with picric acid—x 65 dia.

per cent phosphorus, that is, instead of having an additive effect due greater amounts of constant composition eutectic steadite with each increase in phosphorus content, we have a series of alloys whose properties do not necessarily proceed as a straight-line function. An interesting confirmation of this conclusion is shown in the phosphorus deflection curve. While lacking definite proof it seems likely that the effects of phosphorus on machinability, fluidity, and hardness do not follow arithmetical progression. That is, up to a certain per cent, phosphorus has little effect on machinability. Above this point the metal is much more difficult to machine. The writer's experience and observations on deflection and machinability indicate that a marked change occurs at about 0.50 phosphorus. This is

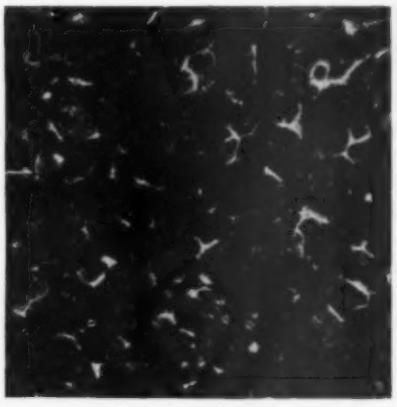


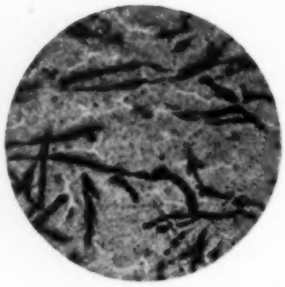
Fig. 19—Iron with 0.35 per cent phosphorus shows little tendency toward grain boundaries—Etched with picric acid—x 100 dia.

borne out by the change in microstructure shown in Figs. 1, 2, 5, 17 and 20*D*.

The steadite forms in gray iron vary with the per cent phosphorus. With low percentages, dendrites consisting largely of the iron plus iron-phosphide solid solution, are found. These dendrites exhibit no cellular structure. They may be distinguished from ferrite by etching with ammonium persulfate; by the absence of grain boundaries characteristic of ferrite; by their characteristic dendritic form; and by relief polishing.

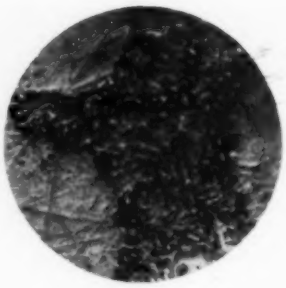
The claim of some writers that the per cent phosphorus can be determined by the microscope, by measuring the steadite areas, is erroneous, since the areas vary in phosphorus content. H. I. Coe has published cooling curves of cast-iron samples containing increasing amounts of phosphorus. The irons examined have 0.09, 0.53, 1.01, 1.23, 2.16 and 2.90 per cent phosphorus re-

A

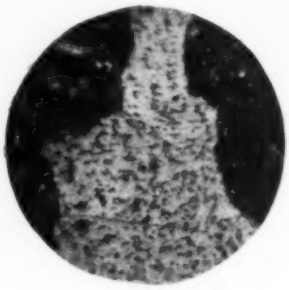


B

Fig. 20-A—Heat tinted to blue with purple spots—Purple along steadite—Iron-phosphorus solution uncolored—Iron phosphide dark—x 500 dia. B—Steadite shown by relief polishing—x 44 dia. C—Relief polishing showing hard steadite—x 610 dia. D—Same as Fig. 2 but at lower magnification—Etched with picric acid—x 470 dia.



C



D

spectively. Unfortunately no irons are shown in the range between 0.10 and 0.50 per cent phosphorus. The curves show that above 0.50 per cent with the increasing amounts of phosphorus the evolution of heat corresponding to the formation of steadite at about 940 degrees Cent. is greater in amount as the per cent phosphorus in the cellular eutectic form.

According to the curve of H. I. Coe phosphorus lowers the actual melting point of cast iron, although this effect is not appreciable in ordinary irons. The influence of phosphorus on fluidity is well known to all foundrymen. High phosphorus irons are well adapted for stove work, radiators etc. where the sections are thin and strong metal is not needed. This is due to the presence of the fluid phosphorus eutectic; melting point about 990 degrees Cent., occuring in irons above 0.50 per cent phosphorus. In a hypoeutectoid iron 1 per cent of phosphorus should give about 10 per cent eutectic.

Much has been written about the network structure often assumed by some steadite in gray iron. It has been claimed by some writers that high strength irons invariably have a network structure, this structure *always* appearing when the metal exceeds about 26,000 pounds per square inch tensile strength.

While readily admitting that the distribution of phosphorus may exert an important influence, the writer cannot concur in the view that the network structure is the all-powerful factor in determining the properties of the metal. An example and a discussion will make this point clear. For example, the metal shown in Fig. 23 certainly has not a well defined network structure when compared to Fig. 24. Now the mixture shown in Fig. 23 when cast in a test bar always exhibits the general structure shown. This mixture followed daily for several years never showed under 26,000 pounds per square inch tensile strength, 28,000 to 30,000 pounds being the strength of over 80 per cent of the tests. The average silicon was 1.25 per cent and the average phosphorus 0.35 per cent. The transverse strength was about 4000 pounds and the deflection about 0.120 inches with 0.60 per cent carbon. Yet Fig. 24, showing a decided network, is from a mixture which never was known to test 26,000 pounds per square inch tensile strength, its range being 20,000 to 24,000 pounds. Average silicon was 1.75 per cent, and phosphorus 0.70 per cent.

That steadite is extruded to the boundaries of pearlite grains is a well authenticated fact. The network structure implies continuity, possibly even an envelope formation, in which case it is logical to expect the envelope formation to form the planes of disintegration, if the envelope is weak. To take a foundry example, consider an oil-sand core. The linoxyn of the linseed oil gives continuity to the mass, but as the linoxyn is weak the fracture is through it rather than through the relatively strong sand grains. On the other hand, if the envelopes are strong, fracture should occur through the grains. Remembering these facts let us consider the actual properties of the phosphorus-rich parts termed steadite. First, insofar as the writer knows, there have been no complete physical tests on pure iron-phosphorus alloys. Steadite is iron—iron phosphide solid solution plus eutectic; 100 per cent eutectic at 10.2 per cent phosphorus.

Solid solutions are invariably harder and generally more brittle than their constituents. That these general rules apply to steadite is shown by relief polishing and by physical tests. It

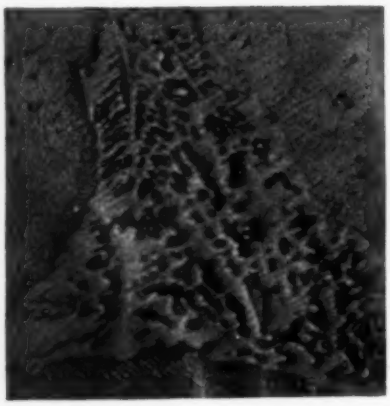


Fig. 21—Relief polishing shows hard steadite and some pearlite lamineæ—x 600 dia.

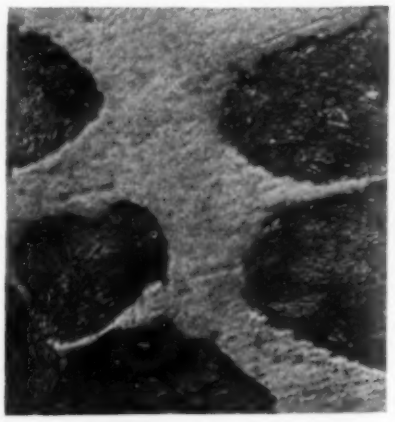


Fig. 22—Charcoal iron; phosphorus, 0.17; combined carbon, 0.71 per cent—Etched with picric acid—x 600 dia.

is quite likely that steadite is stronger than the ferrite which it supplants, and may in this way give some strength to the metal. However, it seems rather unlikely that steadite exceeds pearlite in strength. Unless steadite is stronger than pearlite how can it increase the metal strength?

While it seems doubtful that steadite has a direct influence on strength, the network structure may, in some cases, have an indirect effect. Illustrations in the paper by H. J. Young, republished in THE FOUNDRY April 15, 1922 show particles of massive steadite similar to those shown in Fig. 25. This form of steadite is stated to indicate weak metal. In the writer's experience this is quite true *but* such steadite is usually associated with large graphite. The influence of graphite is so pronounced that any factor which may have a direct or indirect bearing on graphitization may materially modify the properties of the metal. The network structure itself may to some extent hinder the growth of large graphite, and besides, the conditions favorable to formation of a small distinct network also favor small graphite grains.

For heavy castings where strength and machinability are important factors the per cent phosphorus should be kept fairly low. If the iron or semi-steel is melted properly it will possess sufficient fluidity and much phosphorus causes hardness and brittleness.

The worst bill against phosphorus is that it is a hardener. Stead found the hardness of steadite to be 5.5 on Mohs' scale; a hardness approximately that of fieldspar. Simple metallographic proof of this is furnished by relief polishing, Figs. 21 and 20 C. If a gray iron sample is polished a long time, holding it gently against a cloth with soft backing and fine abrasive, the phosphorus-rich dendrite stand out in sharp relief. This shows that they are much harder than the rest of the metal (graphite, ferrite, and pearlite). Indeed they seem almost as hard as free cementite itself. In foundry practice this effect is naturally most noticeable on thin section castings. All foundry handbooks state that high phosphorus irons require more silicon. The writer noted some special castings, containing 1.05 per cent silicon, which cut well in 2-inch sections when phosphorus was about 0.35 per cent but became almost unmachinable when phosphorus was raised to 0.60 per cent, other elements the same.

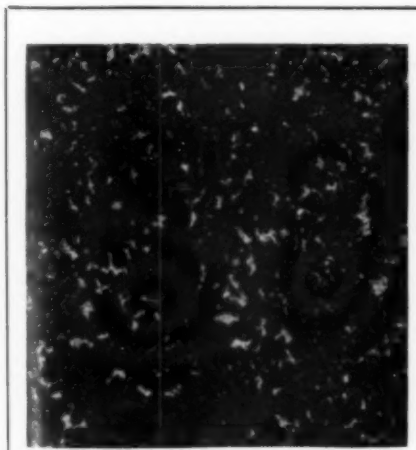


Fig. 23—Iron with a tensile strength of nearly 30,000 pounds per square inch, which shows no well defined network structure—Etched with picric acid—x 50 dia.

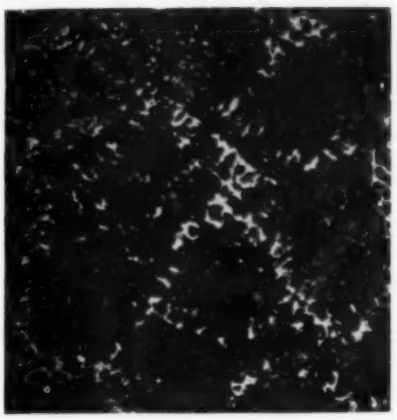


Fig. 24—A much weaker iron than that shown in Fig. 25, but which shows a well defined network structure—Etched with picric acid—x 50 dia.

The effect of phosphorus on the carbon ratios and on the conditions of the carbons is not marked. It lowers the amount of carbon required for the eutectic about 30 points for 1 per cent phosphorus (Wust). It also lowers the temperature at which primary austenite separates some 27 degrees Cent. for each per cent phosphorus (Wust).

While the steadite dendrites are large in irons with large graphite, Figs. 11 and 20 B, this condition is caused by slow cooling rather than by phosphorus. The general effect of phosphorus on machinability may be likened to the effect of many small grains of flint in the metal. The result is a metal harder to cut which is likely to ruin tools quickly.

In addition to general hardening, phosphorus sometimes causes hard spots. These spots sometimes occurring as areas several inches in diameter appear silvery white when the light strikes at certain angles. They are very hard.

The distribution of steadite exerts an important influence as its amount and particular properties; note Figs. 10, 14, 15, 18, 19. The term dendrites used to distinguish the steadite particles really should be female dendrites as the primary dendrites of austenite form into polygonal grains which are generally transformed into pearlite. The steadite is extended to the boundaries of the pearlite or ferrite grains, assuming a negative dendritic or pine-tree form. When the steadite grain boundaries are at all complete, as in Fig. 18, phosphorus will have a marked effect on some of the physical properties, since these latter must depend on the continuous grain boundaries. High phosphorus alloys are brittle, and steadite in certain distributions causes brittle metal.

Authorities do not agree on the influence of phosphorus on strength. We have seen no conclusive evidence that phosphorus weakens the metal appreciably.

Open grain is somewhat influenced by phosphorus. Continuous bands of steadite, as shown in Fig. 18, furnish planes of cleavage which may give rise to open grain appearance. High-phosphorus irons with heavy graphite and much ferrite cut so that the grain is more pronounced than in irons lower in phophorus.

Phosphorus occurring as steadite, gives gray iron fluidity and produces no great lowering in strength. It increases the hardness and lowers the deflection. Above 0.50 per cent phosphorus, in hypoentectoid irons, occurs as binary entectic steadite. Below 0.50 per cent phosphorus, steadite is composed of dendrite containing less than the entectic amount of phosphorus. Further research should demonstrate more clearly the effects of phosphorus on strength and other important physical properties.

Fig. 25—Bar cast in heavy section shows steadite segregated into large isolated dentrite—Graphite flakes large —Pearlite not decomposed—Etched with picric acid—x 65 dia.

Aluminum Melting Practice-II

Heat Values and Application of Different Fuels Are Considered and the Effect of Air and Gases on the Molten Metal Is Studied—Types of Furnaces Described

BY ROBERT J. ANDERSON

THE problem of obtaining fuel for metal-melting furnaces has been one of increasing seriousness in recent years. It is evident that the cost of fuel has risen to such heights that the fuel to be employed has become one of the first considerations in any metal-melting installation.

For every million B.t.u. delivered to the furnace, the average costs may be taken as

For fuel oil	$.82
For natural gas	0.32
For producer gas	0.47
For illuminating gas	1.00
For bituminous coal	0.25
For anthracite coal	0.37
For electric current	3.89

Bituminous coal of various grades is burned in some reverberatory installations used for melting aluminum in rolling-mill practice, but it is rarely used in any of the other types of furnaces. Anthracite coal is used to a subordinate extent in pit furnaces but coke is the preferred fuel for pit furnaces. The kind and source of the coke employed depend upon local conditions, most foundries preferring to use 72-hour Connellsville coke, but by-product coke is coming into more rapid use. Actually, only a relatively small percentage of the domestic production of aluminum alloys is melted in coal—or coke-fired furnaces, and solid fuel may be regarded as relatively unimportant from the commercial standpoint in foundry practice.

Natural gas is, of course, the most popular gaseous fuel, and it is used wherever available. City gas or illuminating gas is employed only slightly in aluminum foundry practice because of its high costs, and in large cities of the central west it cannot compete with natural gas. Neither producer gas nor water gas have been used to any extent in the United States for metal melting, although there appears to be a slight tendency now for fairly large plants to install gas producers or generators for the manufacture of gas on the ground. In certain large cities of the United States where the natural gas supply has become uncertain or where it is curtailed in the winter months, it appears that some plants can economically employ producer gas or water gas in metal-melting furnaces.

The process of combustion of fuels cannot be dealt with in detail here. For the purpose of the present series of articles, it is sufficient to discuss briefly the reactions that take place when the various metallurgical fuels are burned, and to consider the various fuels on the basis of calorific power per unit of cost and their applicability and limitations in the melting of aluminum and its light alloys. From the metallurgical standpoint, combustion is a chemical combination of the combustible material of a fuel with the oxygen of the air, which is attended by the development of heat and light. The development of light (flame) on combustion is quite incidental, although the flame of most of the combustible materials usually has a quite characteristic color. The ignition or kindling temperature of a substance is the temperature to which it must be heated in order that combustion will start.

For the purpose of combustion engineering, air may be regarded as a mixture of oxygen and nitrogen, containing 79 per cent nitrogen and 21 per cent oxygen by volume. In any furnace, the combustion should be as complete as possible, and the heat developed should be utilized to the fullest advantage. In order to obtain complete combustion, it is generally necessary to supply about twice the theoretical amount of oxygen required. Furnace efficiency is directly dependent upon the method of firing and the completeness with which fuel is burned, and the extremely low efficiencies often noted in metal-melting practice may be traced to poor furnace design and to poor methods of firing. When an open-flame tilting furnace is seen with great quantities of flames issuing from the pouring spout, there is evidence that the furnace is being driven too hard, that is, more fuel is being supplied than can be burned in the combustion space above the metal. In aluminum melting, where the attempt is often made to run with a reducing atmosphere, it is certain that much heat is lost through incomplete combustion, in other words, insufficient air supply at the burner.

Coals are of various grades and quality, but for the purpose of this article it is sufficient to consider an average grade of bituminous and anthracite coal. Both these coals and coke are employed in firing pit furnaces for melting aluminum alloys in foundry practice, and bituminous coal is used for firing reverberatory furnaces in aluminum rolling mill practice. The combustion of a bituminous coal containing about 80 per cent carbon, 4.5 per cent hydrogen and 2 per cent sulphur available for combustion may be considered. When carbon burns completely, the product is carbon dioxide, CO_2; when it is burned in a restricted supply of air, the product is carbon monoxide, CO. One pound of carbon burning to carbon dioxide yields 14,540 B.t.u., but if burned to carbon monoxide, it yields only 4380 B.t.u. The hydrogen in coal burns to water vapor, and this condenses to water when cooled below 100 degrees Cent. The sulphur of coal burns largely to sulphur dioxide. Thus, the gases resulting from the combustion of bituminous coal in air consist principally of nitrogen, carbon dioxide, carbon monoxide, oxygen, sulphur dioxide and water vapor. There may be, and usually is, in addition some hydrogen, methane and unsaturated hydrocarbons resulting from the combustion of coal in air. The combustion of coal in a pit or reverberatory furnace will be complete if the supply of air is sufficient and the combustion space large enough.

An anthracite coal may contain about 90 per cent carbon, 2.5 per cent hyrogen, and 0.5 per cent sulphur available for combustion. The combustion products arising on burning an anthracite coal will be necessarily somewhat different in relative percentages than for a bituminous coal owing to the differences in constitution of the coals, but, in general, the same gases will be found in the products of combustion. A fair grade of metallurgical coke may contain about 83 per cent carbon, 0.5 per cent hydrogen, and 1 per cent sulphur available for combustion. The combustion products arising on burning coke will be substantially similar to those from coals except as to relative percentages of the different gases. The combustion of coal has been treated in detail by Kreisinger* and his co-workers and by others, and the information given in the literature is of application in the operation of coal-fired metallurgical furnaces.

The calorific value of solid fuels (coals and cokes) varies considerably

*Kreisinger, H., Augustine, C. E., and Ovitz, F. K., Combustion of coal and design of furnaces, Bureau of Mines. Bull. 135, October, 1917.

depending upon the constitution of the fuel, but it is only necessary here to consider some typical fuels. A good grade of bituminous coal having about 80 per cent carbon, 5 per cent hydrogen, and 2 per cent sulphur available for combustion may have a calorific value of some 14,000 B.t.u per pound. Such a coal will require theoretically about 10.8 pounds of air for complete combustion. With perfect combustion 1 pound of coal will yield about 11.7 pounds of gases; if 100 per cent excess air is supplied, there will be about 22.5 pounds of gases yielded. Hence, it is evident that the volume of flue gases, that is, the amount of the products of combustion, on burning a fuel depends upon the chemical composition of the fuel and the amount of air supplied.

Combustion of Heating Gases

The industrial gases used for melting in metallurgical furnaces include natural gas, by-product gas, and producer gas. Natural gas is highly variable as to composition, but a gas containing about 81 per cent methane and 18 per cent ethane available for combustion may be considered. Small amounts of carbon dioxide and appreciable quantities of nitrogen are normally found in natural gas. Methane burns with oxygen, forming carbon dioxide and water vapor, according to the reaction,

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

Ethane forms the same products upon combustion. The principal gases resulting from the combustion of natural gas with air are nitrogen, carbon dioxide, carbon monoxide, oxygen, and hydrogen, as well as methane, ethane, and unsaturated hydrocarbons in subordinate amount. The relative percentages of the principal gases present depend upon the method of firing and furnace details.

By-product gas is made by the coking of coal, being known locally as city gas, illuminuating gas, and artificial gas. A by-product gas employed for fuel in metal-melting furnaces may contain about 40 per cent hydrogen, 35 per cent methane, 10 per cent carbon monoxide, and 4 per cent unsaturated hydrocarbons available for combustion. Carbon dioxide, oxygen and nitrogen in varying small amounts are also present in by-product gas. Hydrogen burns to water; methane forms carbon dioxide and water as do the unsaturated hydrocarbons; while carbon monoxide burns to carbon dioxide.

Producer gas is rarely used in melting aluminum and its light alloys, although one company uses this gas as a fuel in melting scrap for running light alloys into pig. Producer gas may contain about 12 per cent hydrogen and 30 per cent carbon monoxide available for combustion. The products of the combustion of producer gas are water vapor, carbon dioxide, carbon monoxide and nitrogen. Blue water gas is used by one company in the United States for firing iron pot furnaces in foundry practice. A water gas may contain about 50 per cent hydrogen and 40 per cent carbon monoxide available for combustion.

The calorific power of the various industrial heating gases varies widely. A natural gas containing about 93 per cent methane will have a calorific value of about 1000 B.t.u. per cubic foot, and the heating value of natural gas from various fields varies considerably. The calorific power of by-product gas may be taken as about 600 B.t.u. per cubic foot, while that of producer gas is say 125 B.t.u. Water gas may have a calorific value of about 300 B.t.u. per cubic foot. The calorific value in all gases depends, of course, upon the chemical composition and may be quite variable in a given gas from the same source over a period of time. The combustion of a natural gas containing about 93 per cent methane, 2 per cent hydrogen, and carbon monoxide in small amount may be considered. Under standard conditions, this gas will weigh about 0.046 pound per cubic foot. With perfect combustion, about 15.9 pounds of air will be required for each pound of this gas, and the weight of the products of combustion from a pound of the gas will be about 16.9 pounds. When burned with 100 per cent excess air, the weight of the products of combustion will be 32.8 pounds. The volume of gases arising from the combustion of other heating gases can be readily calculated, knowing their chemical composition.

Combustion of Liquid Fuel

Liquid fuel is becoming favored more and more for use in metal-melting furnaces. Fuel oil is an indefinite term used to include heavy Californian and Mexican crude petroleum, residuum from the distillation of gasoline and kerosene, and often tars. The sulphur content of fuel oil may vary considerably—from 1 to 5 per cent. Crude petroleum is being used less at the present time, and much of the fuel oil employed for metal melting today is a residuum of crude petroleum from which the gasoline at least has been removed. Fuel oil of 33 degrees baume and calorific value of about 140 B.t.u. per gallon is typical.

A California crude petroleum may contain about 84 per cent carbon and 13 per cent hydrogen available for combustion; a residuum contains a higher percentage of carbon. In a liquid fuel, the carbon burns to carbon dioxide and the hydrogen to water vapor. Where fuel oil is atomized with steam—although it rarely is so burned in aluminum-melting furnaces—quite large quantities of water vapor may be present in the furnace atmospheres.

The calorific value of liquid fuel depends upon the kind and source of the fuel. Roughly, the calorific value of a good grade of fuel oil containing about 85 per cent carbon and 13 per cent hydrogen may be about 145,000 B.t.u. per gallon or 19,000 B.t.u. per pound. With perfect combustion, the amount of air required for burning 1 pound of such an oil will be about 14 pounds, or the total products of combustion will weigh 15 pounds. If 100 per cent excess air is supplied, the products of combustion will weigh about 29 pounds.

Effects of Impurities

The question often arises: What is the effect of various impurities in fuels upon the quality of the aluminum or aluminum alloys melted? Unfortunately, no investigations of which the writer has any knowledge have been made upon this subject. Frequently information is desired as to the effect of high sulphur fuel oils, when used in open-flame furnaces, upon the quality of the resultant melted metal. This question is discussed in the light of the available knowledge in the following section on furnace atmospheres.

The constitution of the atmospheres obtaining in metal-melting furnaces of various types is of special interest and importance in considering furnaces for aluminum and aluminum alloys because of the effects of the different constituents of atmospheres upon melting losses. In speaking of furnace atmospheres, it is quite usual, in foundry parlance and elsewhere, to refer to them as oxidizing, neutral or reducing. In melting aluminum and other nonferrous metals and alloys, most melters try to maintain a reducing atmosphere and to prevent an oxidizing atmosphere in the furnace. From the metallurgical standpoint, to determine whether an atmosphere is oxidizing, neutral or reducing, it is necessary to know the exact chemical composition of that atmosphere; the kind of metal or alloy melted, and the effects of the various constituents of the atmosphere upon the metal or alloy at various temperatures. Without these data, an atmosphere cannot be defined. Thus, carbon dioxide may be neutral or oxidizing; it is neutral to liquid copper, but oxidizing to zinc. Magnesium is oxidized by carbon dioxide with the formation of magnesium oxide and the deposition of carbon. Nitrogen, so customarily regarded as an inert gas, readily forms aluminum nitride by interaction with aluminum at moderate temperatures. Unfortunately, the interaction of the various gases, found in furnace atmospheres, with aluminum at

different temperatures have not been thoroughly investigated, and it is consequently speculative to say what the effects of the gases are upon melting losses.

A general axiom in melting practice is that dross losses are higher when the melting is conducted in an oxidizing atmosphere than in a reducing atmosphere, by which is meant atmospheres high in oxygen and high in carbon monoxide respectively. The constitution of any furnace atmosphere is dependent upon a number of governing factors such as the kind and quality of the fuel used; type and design of the furnace; and operating conditions, including volume of air supply in relation to fuel supply.

Constituents of Furnace Atmospheres

From the standpoint of correct melting practice, it is important to consider here briefly the various constituents which may occur in furnace atmospheres and the possible effects of these constituents.

Carbon dioxide is a frequent constituent in practically all types of furnaces used in the commercial melting of aluminum and its light alloys. Where the attempt is made to operate with a so-called reducing flame, the air supply is restricted, and the fuel is burned largely to carbon monoxide rather than to carbon dioxide. Of course, much of the possible heat is sacrificed in this way.

The effect of carbon dioxide upon the properties of aluminum has not been examined in detail so far as is known. It has been suggested by Franck, Richards, and others that carbon dioxide acts on aluminum forming aluminum oxide and setting free carbon, according to the formula:

$$4Al + 3CO_2 = 2Al_2O_3 + 3C$$

The temperature is not given but it apparently must be quite high under atmospheric pressure. If true, carbon dioxide should be regarded as oxidizing to aluminum at high temperatures; it is probably neutral at normal melting-furnace temperatures. At the latter, it evidently acts like an inert gas toward aluminum and aluminum oxide. When present in large percentages in a furnace atmosphere, carbon dioxide should tend to reduce dross losses, although in furnace practice excess of air is generally required for this condition. This, of itself, would tend to increase oxidation because of the presence of much free oxygen.

Carbon monoxide is a frequent constituent of melting-furnace atmospheres. In certain types of furnaces, it is normally present in small quantities, under ordinary operating conditions, but the amount contained can be varied within wide limits by varying the firing. When there is a high carbon monoxide content either in the flue gases or in the actual furnace atmosphere, the fuel efficiency is necessarily low due to incomplete combustion owing to lack of sufficient air. Both melters and furnace makers recognize the desirability of a so-called reducing atmosphere, that is, one high in carbon monoxide, for melting aluminum and its light alloys. The operating efficiency of furnaces run with such atmospheres must be low.

The effect of carbon monoxide upon the properties of aluminum has not been studied so far as is known. It has been suggested by Franck and by others that carbon monoxide acts on aluminum to form aluminum oxide, setting free carbon, according to the formula:

$$2Al + 3CO = Al_2O_3 + 3C$$

On the other hand, Pring explains the formation of aluminum carbide in the electric furnace by the reaction

$$6\ Al + 3CO = Al_4C_3 + Al_2O_3$$

Carbon monoxide would thus be seen to be oxidizing to aluminum; but evidently high temperature is a prerequisite to both the above reactions. Some aluminum carbide is formed on melting aluminum in arc furnaces, and this may be due to the action of carbon monoxide on aluminum or to the direct union of carbon and aluminum. According to Pring, carbon and aluminum can unite directly *in vacuo* to form aluminum carbide, the reaction being perceptible at 650 degrees Cent., and rapid at 1400 degrees Cent. So far as is known, aluminum carbide is not formed in the ordinary melting of aluminum or its light alloys in fuel-fired furnaces. Probably, carbon monoxide is neutral to aluminum at the normal melting temperature.

Free cyanogen is of comparatively rare occurrence in furnace atmospheres. Cyanogen is formed in small amounts when a discharge of electricity takes place between carbon electrodes in the presence of nitrogen. Thus, cyanogen is normally present in small amount in the atmospheres of arc-type electric furnaces. No studies have been made of the effects of this gas upon aluminum, but it apparently is inert.

Hydrogen is a frequent constituent in fuel-fired furnace atmospheres, and it has also been found in the atmospheres of electric furnaces. The presence of hydrogen in a fuel-fired furnace normally indicates incomplete combustion since the hydrogen in a fuel should burn to water. Usually the amount present is small. The effect of this gas upon aluminum has not been examined so far as is known. However, hydrogen appears to have no direct action upon aluminum, and hydrides of aluminum are not formed.

Methane, in appreciable amounts, may occur in the atmospheres of furnaces fired by methane-containing fuel, due to incomplete combustion. It can scarcely be doubted that no methane is formed by the direct union of carbon and hydrogen in a furnace atmosphere. The percentage of methane present is usually quite small. The effect of methane upon the properties of aluminum has not been made the subject of investigation, but so far as is known, methane is neutral to aluminum at normal melting temperatures.

Nitrogen is a normal constituent of all furnace atmospheres, being derived from the air. It is, of course, evident that nitrogen will always constitute a large percentage of the atmosphere in any fuel-fired furnace since air is required for combustion. Nitrogen is found in large amounts in electric-furnace atmospheres but generally in smaller percentages than in fuel-fired furnaces. The effect of nitrogen upon the properties of aluminum has not been studied in detail.

Oxides Are Harmful

Free, uncombined oxygen may be present in varying amounts in the atmospheres of industrial melting furnaces used for aluminum and its light alloys. Ordinarily, free oxygen is the result of a large excess air supply, but it is possible that considerable carbon monoxide may be present in furnace gases together with some oxygen. At the same time, free oxygen is present in open-flame furnaces when run with an excess air supply; in this case, both oxygen and carbon dioxide may be present in large percentages together with nitrogen. From the foundry standpoint oxidizing atmospheres are regarded as harmful, owing largely perhaps to the formation of aluminum oxide.

Sulphur dioxide may be present in furnace atmospheres in appreciable amounts when high-sulphur fuels are burned. No studies have been made of the effect of sulphur dioxide upon the properties of aluminum, but evidently, at the ordinary melting temperature, sulphur dioxide does not interact with aluminum.

Under unsaturated hydrocarbons there may be included here only the olefin and acetylene hydrocarbons. Ethylene, C_2H_4, and related unsaturated hydrocarbons burn in the air with a highly luminous flame, owing to the separation of free carbon. Unsaturated hydrocarbons occur in various furnace atmospheres and are the result of incomplete combustion. No examination of the effects of these gases upon the properties of aluminum and its alloys has been made, so far as is known, but apparently, they are neutral to aluminum at normal melting temperatures.

Water vapor is a constituent of many

furnace atmospheres, and it results from the combustion of free or combined hydrogen. Some furnace atmospheres, as in furnaces where steam is used for the atomization of oil, may contain high percentages of water vapor. No studies have been made of the effect of water vapor at various temperatures upon the properties of aluminum, but it appears likely that steam interacts with aluminum to form aluminum oxide or aluminum hydroxide or both.

The constitution of the gas atmospheres in a metal-melting furnace may present peculiarities from the standpoint of combustion practice. The gases in the interior of an open-flame furnace may be in process of burning at any given instant, and the constitution of the actual furnace gases should not be expected to be the same as that of the waste gases discharged. Hence, although it might appear from a gas analysis that combustion was incomplete and the furnace efficiency was low, it is to be remembered that the constitution of the atmosphere is no absolute criterion of the efficiency with which fuel is burned. Gas analyses of the atmosphere may show tendencies, but the exit or flue gases must be analyzed in order to determine whether the fuel is burned completely in the furnace.

From the standpoint of melting losses, it is of importance to know what the average analysis of the furnace atmosphere in contact with liquid metal is under foundry operating conditions. In stationary iron-pot furnaces run without a cover the atmosphere in contact with the liquid metal is practically unaltered air. The metal is effectively protected from the products of combustion since the pots are heated over their exterior surfaces by the combustion of the fuel and the waste gases are discharged so as not to come into contact with the metal.

In stationary iron-pot furnaces run with covers so that there is at most only a restricted access of outside air to the surface of the liquid metal, the gas atmosphere might be expected to become leaner in oxygen and richer in nitrogen after the cover was closed for some time, owing to the depletion of the oxygen through its interaction with aluminum. Some carbon dioxide might be present owing to the interaction of the carbon in the cast iron with oxygen. Gas samples taken from a single-unit, stationary iron-pot furnace run with a closed cover and fired by natural gas showed the following limiting percentages in a number of samples; 7.2 to 9.8 per cent carbon dioxide, 84.7 to 86.6 per cent nitrogen, and 3.5 to 8.1 per cent oxygen. Small amounts of carbon monoxide, hydrogen and unsaturated hydrocarbons were also found; the presence of the two latter constituents at least indicates a possible leakage from the combustion space through the pot.

In stationary crucible furnaces, where the crucible is not covered, there is ample opportunity for the products of combustion to come into intimate contact with the metal during melting. In these furnaces, the crucible is heated over its exterior surface, generally by oil or gas, and the products of combustion are discharged with a rotary motion around the crucible and out through a hole in the furnace cover. In tilting crucible furnaces, as in stationary and tilting iron-pot furnaces, the metal is usually fairly well protected from the products of combustion. Of course, when a new plumbago crucible is put into service, the burning out of the graphite will give rise to much carbon dioxide or carbon monoxide or both, depending upon the air supply. Gas samples taken from a stationary crucible furnace fired by natural gas gave the following limiting percentages of the constituents: 6.7 to 10.8 per cent carbon dioxide, 1.9 to 6.3 per cent carbon monoxide, 0.7 to 6 per cent hydrogen, 0.3 to 4.1 per cent methane, 0.0 to 1.3 per cent unsaturated hydrocarbons, 0.0 to 4.5 per cent oxygen, and 77.6 to 85.4 per cent nitrogen. The variations in the percentages of carbon dioxide, carbon monoxide, hydrogen and methane are traceable to variations in the air supply and in the speed of combustion.

In another furnace of this type fired by oil, the range of composition of a number of samples was as follows: 12.8 to 14.5 per cent carbon dioxide, 2.0 to 4.2 per cent oxygen, and 82.8 to 83.6 per cent nitrogen. The combustion in this furnace was evidently better than in the preceding one.

The atmosphere in contact with metal in the usual type of tilting crucible furnace, that is, one with a plumbago crucible with a molded pouring spout luted into a furnace shell, hung in a furnace, consists of practically unaltered air. Gas samples taken from a special type tilting coke-fired crucible furnace using both natural and forced draft are of interest, however, as they show what may be expected in pit coke furnaces and other furnaces burning solid fuel. In this particular furnace, the waste gases from the burning coke passed up and around the crucible and were discharged through a large hole in the furnace cover, as in the usual stationary crucible furnace. When run on natural draft, the range of composition of the atmosphere was as follows: 2.4 to 9.2 per cent carbon dioxide, 10.5 to 17.9 per cent oxygen, and nitrogen practically uniform at 79.0-79.7 per cent. With an increase in oxygen, a decrease in the percentage of carbon dioxide occurred and *vice versa*. When the furnace was run on a strong forced draft, the range of composition was as follows: 12.8 to 16.7 per cent carbon dioxide, 0.2 to 6.8 per cent oxygen, and 74.4 to 80.9 per cent nitrogen. The carbon monoxide content was variable over a wide range.

The atmosphere of the open-flame furnace is probably more dependent upon the operating conditions than any other because combustion takes place in the melting chamber directly over the surface of the metal. The products of combustion are intimately in contact with the metal during melting and the flames actually impinge upon the surface of the bath. Gas samples taken from an open-flame egg-shaped tilting furnace fired with oil showed the following range of composition: 7.2 to 14.5 per cent carbon dioxide, 0.0 to 7.9 per cent carbon monoxide, 0.0 to 4.7 per cent hydrogen, 0.0 to 5.7 per cent oxygen, and 75.3 to 83.4 per cent nitrogen. Methane up to 2 per cent was found in some of the samples. At times the atmosphere in this furnace was plainly oxidizing; during others the oxygen content was low and the carbon monoxide content was quite high. In a few samples both the oxygen and the carbon monoxide were present in appreciable amounts.

The gas atmospheres in open-flame stationary cylindrical furnaces may be expected to be about the same as those in the tilting type, but in both types the operating conditions are the determining factors. Gas samples taken from a large cylindrical open-flame furnace, fired by oil, showed the following range of composition: 12.8 to 14 per cent carbon, dioxide 0.0 to 2.9 per cent carbon monoxide, 0.0 to 1.7 per cent hydrogen, 0.2 to 2 per cent oxygen, and 82.2 to 84.5 per cent nitrogen. Small amounts of methane were found in some of the samples. The analyses indicate good combustion, and the atmosphere may be regarded as substantially neutral for practical purposes.

In reverberatory furnaces, there is ample opportunity for the flames and products of combustion to come into contact with the metal during melting. In these furnaces, the fuel is burned at one end, and the products of combustion sweep over the metal to the other end; or burners may be placed in opposite sides of the furnace, and the waste gases discharged through a stack at one side or at one end. Samples taken from a reverberatory furnace, fired by oil through three burners at one end, showed a range of composition as follows: 3.4 to 6.5 per cent carbon dioxide, 12 to 17.6 per cent oxygen, and 79.6 to 82 per cent nitrogen. This is an oxidizing atmosphere.

In indirect-arc, smothered-arc, and in granular-resistor electric furnaces, the atmospheres may be expected to contain large quantities of carbon monox-

ide, caused by the burning of carbon in a restricted supply of air. Samples of gas taken from an indirect-arc, rocking electric furnace, showed that for a short melting period the range of composition was 21 to 39.3 per cent carbon monoxide, 50.5 to 72.6 per cent nitrogen, and small percentages of oxygen and carbon dioxide. The hydrogen content was appreciable, and methane and cyanogen were found. Over a long melting period, samples taken every few minutes showed continual marked changes in the constitution of the atmosphere. Thus, the carbon monoxide content, while high at the beginning of a run, gradually becomes less, as does the hydrogen. The depletion of the carbon monoxide content may be described to the interaction with aluminum, since the carbon dioxide content does not vary concordantly.

Gas samples taken from a granular-resistor electric furnace gave the following range of composition: 12.4 to 19.9 per cent carbon dioxide, 1 to 16.6 per cent carbon monoxide, less than 1 per cent oxygen, and nitrogen high and variable. Hydrogen and methane were present in small quantities. The original atmosphere of the furnace, immediately after charging, should be high in oxygen, owing to the ingress of air through the door. With the door closed and the air ingress stopped, the oxygen already in the furnace combines with the red hot carbon of the resistor, forming carbon dioxide. This subsequently interacts with the hot carbon, and combines forming carbon monoxide.

The occlusion of gases by aluminum and its light alloys on melting is of interest rather from the standpoint of casting and working than from the standpoint of melting losses, but it is closely dependent upon the constitution of the furnace atmosphere. Little authoritative information is available as to the solubility of gases in aluminum, as to their effects upon the properties of the metal, or as to their interaction with the metal at various temperatures.

Rosenhain has regarded the amorphous films surrounding the grains in metals as the vehicles or carriers of the dissolved gas, and the gas as actually dissolved and not merely enclosed or suspended in the solid crystalline aggregate. The gas absorbed in a metal may not be in the gaseous state but in solid solution and under high pressure, just as when salt is dissolved in water the salt is liquified and exerts a pressure (solution pressure).

Liquids, in general, dissolve less gas with increasing temperatures, but molten metals depart from this law and dissolve more gas with increasing temperatures. Hence, the higher aluminum or its light alloys are heated prior to pouring, the more gas will be dissolved. According to the available information, the solubility of gases in liquid metals does not appear to obey Henry's law. Not much work has been done to date on gases in aluminum, but Gwyer states that hydrogen is the predominant gas in aluminum. Gwyer* found that cast aluminum which showed exceptional blistering after rolling into sheet and annealing contained 1/10 to 1/3 of its own volume in occluded gas, and that the composition of the gas varied exceedingly. For cast aluminum which had given this difficulty, it was found that the gas given off on heating varied as to composition as follows: Four to 8 per cent carbon dioxide by volume; 0 9.5 per cent carbon monoxide, 1 to 24.5 per cent methane, 55 to 81 per cent hydrogen, 1.5 to 4.5 per cent oxygen, and 5 to 11 per cent nitrogen.

A furnace which does not bring the products of combustion into contact with the metal melted is regarded as desirable by some foundrymen, but it is evident that if the combustion products are not dissolved appreciably then open-flame furnaces are entirely suitable. In the light of the available evidence, oxygen, nitrogen and hydrogen appear to be the most harmful gases—the first two because they combine with aluminum at normal melting temperatures and hydrogen because it appears to be readily soluble in the metal. Probably any commercial furnace can be operated so as to give but relatively little trouble from dissolved gas, but if a suitable molten flux cover is used on the surface of the metal it would appear that some of the present oxidation difficulties could be reduced.

*Gwyer, A. G. C., in discussion of papers on Occlusion of gases by metals, Trans. Faraday Soc., vol. 14, 1919, pp. 173-263; see p. 254.

Weld Monel Metal Using Deoxidizers

WORKING under the theory that behavior of a metal in the foundry htrows light on its behavior during welding, a research in arcwelding monel metal was made by P. D. Merica and J. G. Schoener who report the results of their investigations in a paper recently presented before the New York section of the American Welding society. The authors say: When monel metal, is melted and brought to the correct *pitch;* that is, when it has the right carbon content, which varies according to the use from 0.10 to 0.30 per cent, a casting poured from it either in a chill or in a sand mold will in general neither be malleable, ductile nor free from blowholes. However, the addition of ferromanganese or metallic manganese together with about 0.1 per cent of metallic magnesium will *deoxidize* the molten metal and a casting or ingot poured subsequently will be both sound and ductile.

It seemed apparent from consideration of the first difficulties encountered in arc welding that the metal melted by the arc absorbed so much oxygen from the surrounding air that it required re-deoxidation to make it again malleable and sound. It may be observed that special deoxidation is not necessary in oxacetylene welding because the operator uses a reducing flame which protects the hot and molten metal from the air.

We have definitely ascertained that just as monel metal must be deoxidized before casting into sand molds and ingots so also must it be deoxidized in producing satisfactory arc welds. And the agents which are found to be superior for this purpose are the same as those used in the foundry; namely, magnesium, manganese and silicon, in the order of their importance for this operation.

We have found that these agents are best employed in the form of alloys, ground to from 50 to 100 mesh and applied to the welding rod of bare monel wire as a thin coating. It is obvious that the alloys used for this purpose must be sufficiently brittle and preferably soft, that they can be powdered. The binder which we have found successful is made up of denatured alcohol containing ½ pound of shellac to the gallon. Other similar binders would undoubtedly serve equally well.

According to our experience the exact composition of this coating powder may vary within moderately wide limits, the essential requirement being to introduce into the welded metal about the amounts of manganese and silicon, and particularly of magnesium, which are generally used for deoxidation in the foundry. Thus we should introduce from 0.05 to 0.50 per cent magnesium, from 0.20 to 1.00 per cent silicon, and at least 0.20 per cent manganese but an excess of this element is not harmful. However, an excess of magnesium or silicon will tend to produce dirty or brittle metal respectively.

We have applied these coatings dry simply by making a suspension of the powder in the dilute shellac solution and dipping the wire into it and allowing it to dry. The coating can also be applied

by brush, although at greater expense of time and with greater loss of material. This coating we have found adheres well and will not be removed by packing and transportation. It will vary in thickness, but on a 5/32-inch wire will run about a pound to 600 feet and approximately 2 per cent by weight of the wire.

The alloys to be used in the preparation of the powder may vary widely when consistent only with the condition that all must be powdered and that certain limits already noticed as to magnesium and silicon content be maintained. We have had entire success using ferromanganese or metallic manganese and one of the silicon-manganese magnesium alloys produced by the Electric Metallurgical Co., and having the following composition:

	Grade No. 1 Per cent	Grade No. 2 Per cent	Grade No. 3 Per cent
Magnesium..	25 to 30	14 to 16	8 to 10
Manganese..	20 to 25	27 to 33	45 to 50
Silicon.....	35 to 40	45 to 50	40 to 45
Carbon.....	Max. 0.20	Max. 0.20	Max. 0.20

Any of these alloys can be used alone or in conjunction with from 1 to 2 parts of ferromanganese. Of course, other alloys or combinations can be used to give similar results. We have used the manganese-mangnesium-silicon alloys No. 1 and No. 2 alone and in conjunction with equal parts of ferromanganese and have not been able to observe much difference between the results with the different composition.

Ferromanganese alone or with ¼ of ferrosilicon give good welds at times, but they are not as consistently sound and ductile as those made with the simúltaneous use of some magnesium. The latter seems to be the essential part of the coating, and although the manganese and silicon aid in deoxidation and in producting proper fluidity of the molten metal, and consequently a good weld surface, they serve perhaps also in large part as a diluting carrier for the magnesium. The latter cannot be ground and it is also too reactive to be used in the pure form as it oxidizes before it gets into the weld. The manganese and silicon act to protect it until it is absorbed in the molten weld. A nickel-magnesium, nickel-copper-magnesium or nickel-silicon-magnesium alloy of similar type could be used as well for magnesium carriers as they are also brittle. Welds made with these deoxidizers are sound and practically as ductile as are welds on ordinary varieties of low-carbon steel. Aside from the use of the special deoxidizer described, arc welding with monel metal is not essentially different in detail from that with steel. With work ¼-inch thick and over, a 5/32-inch diameter welding wire of monel metal should be used, and for work from 1/3 to 1/4-inch, 3/32 to 1/8-inch wire is required, the best currents being 180 to 200 and 75 to 125 amperes respectively.

It is preferable to make the whole weld at one operation and not to build it up in successive layers, as the latter method will likely give cracks and unsoundness. The weld should be well built up above the surface, as there are almost invariably small pinholes just under the surface of the weld, even with best welding practice.

An important variation from usual practice with steel is that of making the welding rod the positive pole instead of the work. When the latter is made positive the metal tends to drop from the electrode and does not flow freely and continuously.

The plate, rod or casting to be welded should be well cleaned of all scale by grinding or machining on both sides of the edge and it is well to coat these edges, by the use of a brush, with the same deoxidizer as is used on the rod.

Rough Grinding With Special Wheels

BY E. D. BISHOP

ROUGH grinding involves a large variety of work and generally is performed on swing-frame and floor grinders. Portable grinders also are employed extensively where it is not practicable to use large wheels. The swing-frame grinder may be utilized for finishing parts that are too large or too heavy to be ground on a floor-type machine. As the wheel is mounted on movable arms and because the castings are comparatively rough, the wheel is subjected to considerable vibration. For the foregoing reasons it is important to select the correct wheel grit and grade. If the grade is too soft the wheel is liable to wear out-of-round, causing excessive vibration. If it is too hard it will glaze readily. The wheels on swing-frame grinders should be mounted between safety flanges.

For grinding steel castings on large wheels, 20 inches in diameter and over, a coarse combination grit in a hard grade, such as American corundum 10/12 combination grit, Q grade, will give good results. Smaller wheels should be used in finer grits. Coarse, straight-grit wheels, however, are productive of excellent results for grinding manganese steel safes. Wheels, 16 inches in diameter 3-inch face, 16 grit, P grade, have proved satisfactory on this work. Under some conditions, coarser or finer grits can be employed. The correct selection depends on the size of the work, size of wheel and the finish required. It frequently is necessary to experiment to determine the most efficient grit and grade.

Small Units Used

Small portable grinders are used to advantage for cleaning large castings, especially those having surface depressions that cannot be reached with large or wide wheels. Portable grinders are of two general types, namely flexible and fixed shaft. The flexible shaft units are driven by compressed air, electricity, or through an overhead drive. The fixed-shaft outfits embody a power plant, either an electric motor or a compressed air engine, direct-connected to the grinding wheel. These machines are productive of excellent results when equipped with wheels of a suitable grit and grade for specific operations. The wheels range from 6 to 10 inches in diameter and are from ½ to 1-inch wide. For grinding steel castings, 24 grit, R grade generally is satisfactory. For cast iron grindings, a carbide of silicon wheel, such as 24 grit, T grade carbolite, will give good results.

The author is manager of the E. D. Bishop Co., Cleveland, agent for the American Emery Wheel Works, Providence, R. I.

Contract New Foundry

The Consolidated Machine Tool Corp., Wilmington, Del., has awarded the contract for a new steel foundry to Beling-Bush Co., Inc., Philadelphia. Work will be started immediately. The building is to be of brick and steel, one story, 85 x 250 feet, with pattern shop in one wing. Two overhead cranes are to be installed by the builder. This plant will be known as the Hilles & Jones Co.

Increase Casting Output

The Standard Foundry Co., Racine, Wis., producers exclusively of the high grade automobile cylinder block castings, have leased the large, new and completely equipped gray iron foundry of the J. I. Case Plow Works, Racine, Wis., thereby enabling the Standard Co. to triple present tonnage. The Case foundry will be devoted exclusively to cylinders.

How and Why in Brass Founding

By Charles Vickers

Cheap Ferrule Mixtures

We are trying to make brass ferrules and would like to get a suitable mixture for the same. Can we make them of brass scrap, bought on the market? And what additions in the way of zinc, lead and aluminum should be made? We are gating them four in a mold, the ferrules being vertical with the down gate in the center of the square formed by them and runners are straight with a broad gate into each casting.

Scrap can be used for ferrules, but unless the analysis is known it would be impossible to advise what additions of zinc, lead and aluminum should be made to cheapen it. Use the following alloy:

CHEAP ALLOYS FOR FERRULES

	Pounds	Ounces
Scrap copper	54	11
Zinc	40	0
Lead	5	0
Aluminum	0	5

Thousands of ferrules have been cast to the above formula. Do not pour it so hot that it smokes strongly as it is highly fluid metal and will run well.

If the ferrules are small and rather thick they can be run when gated as described, but the large ferrules will never run that way in any metal or alloy. These are cast one to a gate, and the latter is placed on top of the ferrule. It is a three-legged gate with the legs joined on top of the green-sand core at which point the down gate, which is about 7/8 inch diameter, is attached. On top of the down gate a wide head is needed, for a miss in pouring means a bad casting.

Special Aluminum Alloy Resists Pressure

We should like to learn if it is standard practice to cast aluminum tanks to withstand a pressure of from 50 to 70 pounds. We are making 3-gallon capacity tanks which at first leaked around several small bosses located at various points. We stopped the leaks at those points by the use of chills, but we cannot close the grain of the metal sufficiently to prevent leaks at other points. The core is just a ½-inch shell made on an arbor and we are quite certain it yields sufficiently during contraction of the casting and therefore is not responsible for seemingly invisible cracks that would cause leaks. We shall appreciate your suggestions.

Ordinary alloys of aluminum will not withstand pressures of more than a few pounds on account of the coarseness of grain. To withstand any considerable pressure it is necessary to close the grain of the metal and this can be done by increasing the amount of the hardening agent in the alloy. Thus a No. 12 aluminum will contain around 92 per cent aluminum and 8 per cent copper if made from new materials. The same alloy if made from remelted material will contain from 1 to 2 per cent iron and possibly a small amount of zinc. To produce a metal more impervious to gases and liquids under pressure, the copper content is raised to as high as 12 per cent. This makes an exceedingly close grained metal that will hold pressures well. In addition to the foregoing, special alloys are on the market made for the express purpose of resisting pressure. One of these has been employed extensively to resist water pressure up to 300 pounds per square inch.

Glass Used To Protect Metal from Flame

We would like to learn why liquid glass is used in melting brass; is it a flux, or does it merely protect the metal from the flame? Also is it possible to make castings from brass melted in an oil-fired non-crucible tilting furnace that will stand a high pressure.

By liquid glass, we suppose that molten glass is meant. Glass is used by some melters, and simply acts as a covering to the metal, protecting it from the gases of combustion. It has no fluxing action. The sticky mess to be skimmed off the metal renders it objectionable to some melters under certain circumstances; but in cases where the blast is strong enough to blow charcoal off the metal, some substance of a glassy nature has to be used to prevent the metal from burning.

There is no reason why pressure castings cannot be made from metal in non-crucible furnaces. The fuel and air can be adjusted to prevent oxidation of the metal. If the metal is free of oxides, and the castings have been properly gated and fed, they will stand pressure, as well as castings made of metal melted in any other manner.

Duplicate Articles Die-Cast in Aluminum

We desire to learn if there is such a thing on the market as a permanent mold for casting aluminum. We make thousands of duplicate castings and could use a permanent mold to advantage, and will appreciate any information you may be able to give us.

No; there is no permanent mold on the market for the purpose outlined. Aluminum is being cast in molds more or less permanent; that is molds that can be used for more than one casting; in fact for thousands of castings from each mold. This process is known as die-casting and manufacturers who have achieved success in this particular line are very secretive about it because it has cost them large sums to overcome the difficulties encountered and to put the process on a paying basis. Naturally they do not feel like presenting this costly experience to the public to stimulate competition against themselves.

The answer to the foregoing question therefore, is that a permanent mold can not be purchased for example, like one may buy a melting furnace. The art has not reached that state of development, and it would be necessary to work out the process oneself. Castings as large as pressure cookers would be a little large for the die casting method, although quite large castings have been so made.

Monel Metal Composition

We have some castings to make of monel metal and will appreciate your supplying us with a formula for it.

A typical analysis of cast monel metal is given by Paul D. Merica, superintendent of research, International Nickel Co., as follows: Manganese, 0.25 per cent; carbon, 0.18 per cent; iron, 1.90 per cent; silicon, 1.06 per cent; sulphur, 0.03 per cent; copper, 28 per cent; nickel, 68.58 per cent, approximately.

It is not advisable to make the alloy from any formula, as monel metal is a *natural* alloy; that is, it is made from ores by smelting methods. It can be purchased in ingot form. As monel metal has a high melting point, a furnace capable of reaching a steel-melting temperature quickly is what is wanted. It is a good plan to make the castings in dry sand molds.

METHOD FOR ANALYSIS OF MANGANESE BRONZE

By Ernest J. Davis

It is important to get a representative sample for analysis. If a shipment of ingots is to be sampled, a number are chosen at random and drillings taken from each ingot—drilling completely through the ingot. These drillings must be well mixed. In sampling pots of metal a small ingot should be cast from each pot after the bath is well stirred. These small ingots are then melted down together and a sample cast from the well mixed bath. Drillings then may be taken from the bar and should be well mixed. In every case all traces of free metallic iron should be removed with a magnet before starting the analysis.

Zinc, Iron, Manganese and Nickel

Weigh into a 400 c.c. beaker 1 gram of the drillings and dissolve in a mixture of 25 c.c. water, 25 c.c. hydrochloric acid and 5 to 10 c.c. nitric acid. Dilute to about 250 c.c. and make alkaline with dilute ammonia (1 to 1). Reacidify with hydrochloric acid and add 2 c.c. in excess, then heat nearly to boiling. Add 30 c.c. of a mixture of ammonium sulphocyanide and sodium sulphite (50 grams of sulphocyanide and 60 grams of sulphite per liter) and stir well. Allow the precipitate of copper to settle and filter through a double filter paper washing with hot water. Add 10 c.c. of nitric acid to the solution and boil for ½ hour, cool and oxidize with bromine, then add dilute ammonia (1 to 1) in excess and boil. Allow to settle in a hot place and filter washing well with ammonium chloride solution. The filtrate is kept for the determination of zinc and nickel. Dissolve the precipitate in hydrochloric acid and carefully neutralize with ammonia, leaving the solution a dark red color but with no precipitate of iron. Then add 15 c.c. of a 20 per cent solution of ammonium acetate and bring the solution to a boil. Filter off and redissolve the precipitate in a little hydrochloric acid. Now add ammonia in slight excess and a few crystals of sodium sulphite. Reacidify with hydrochloric acid and boil off sulphur dioxide; cool thoroughly and titrate with potassium bichromate.

1 c.c. potassium bichromate=0.0056 gram iron

The filtrate from the basic acetate separation contains the manganese. Add bromine to this solution and an excess of ammonia and boil. Allow the precipitate to settle and filter off through an ashless filter paper; wash well with hot water. Ignite and weigh as Mn_3O_4. The weight multiplied by 0.72026 equals the percentage of manganese.

Zinc and Nickel

Evaporate the solution from the precipitation of the iron and manganese to between 200 and 300 c.c. and transfer it to a 600 c.c. beaker. After raising it nearly to boiling add 50 c.c. of a 20 per cent solution of ammonium phosphate and allow to stand on the hot plate for ½ hour. Filter and wash with a small amount of hot water. Dissolve the precipitate in 10 c.c. of concentrated hydrochloric acid into the original beaker and neutralize with ammonia. Reacidify with hydrochloric acid adding 3 c.c. in excess and dilute to 250 c.c., then raise to 60 degrees Cent. and titrate with potassium ferrocyanide.

1 c.c.=0.010 grams zinc

Nickel

Add a few c.c. of an alcoholic solution of dimethylglyoxime to the filtrate from the zinc phosphate precipitation and make the solution alkaline with ammonia. After standing for 1 hour on the hot plate

(*Concluded on Data Sheet No.* 448)

METHOD FOR ANALYSIS OF MANGANESE BRONZE

(*Concluded from Data Sheet No.* 447)

filter off the precipitate of nickel dimethylglyoxime and wash with hot water. Carefully ignite and weigh as nickel oxide containing 78.7 per cent nickel.

Copper

Weigh 0.25 grams of drillings into a 300 c.c. flask and dissolve in a small quantity of nitric acid. Boil off the excess of nitric acid and neutralize the remainder with sodium carbonate. Then make slightly acid with acetic acid and cool. Add potassium iodide to the solution and titrate with N/10 sodium thiosulphate using starch solution as indicator.

1 c.c. N/10 sodium thiosulphate=0.0063 grams copper

Tin and Lead

Dissolve 5 grams of drillings in 30 c.c. of dilute nitric acid (1 to 2). When all is in solution evaporate to a low bulk and dilute to 300 c.c. Boil for ½ hour and allow to settle. Filter on an ashless filter paper and wash well with hot 5 per cent solution of nitric acid. Dry, ignite and weigh as SnO_2 which multiplied by 0.7884=grams tin.

The filtrate, after this addition of 10 c.c. of sulphuric acid, is evaporated to sulphur oxide fumes and after being cooled is diluted with water and allowed to stand over night. The lead sulphate is then filtered on a tarred gooch crucible and washed with dilute sulphuric acid, dried, ignited and reweighed.

Increase in weight x 0.6829=grams lead

Aluminium

Dissolve 2 grams sample in a mixture of 30 c.c. hydrochloric, 10 c.c nitric acid and 40 c.c. water in an 800 c.c. beaker. Boil off nitrous fumes and dilute to about 500 c.c. with water, then pass through hydrogen sulphide gas and allow to settle. Copper, lead and zinc are then removed. Filter off the precipitate and wash with hydrogen sulphide water. Evaporate the filtrate to 300 or 400 c.c. then add 6 c.c. of a 2 per cent iron solution and 10 c.c. nitric acid. Boil until free from hydrogen sulphide, then make alkaline with dilute ammonia (1 to 1) and boil for 10 minutes. Filter and wash well with ammonium chloride solution to free zinc. Dissolve the precipitate in dilute hydrochloric acid (1 to 1) dilute to about 400 c.c. and neutralize with ammonia. When just alkaline but with no precipitate of iron add 10 c.c. of a 20 per cent ammonium acetate solution to the clear dark red solution and bring to a boil. Allow the basic acetate precipitate to settle and filter, then wash with hot water and dissolve in dilute hydrochloric acid (1 to 1). Now add 20 c.c. of a 10 per cent solution of sodium phosphate and make the solution just alkaline with dilute ammonia (1 to 1) then acidify with hydrochloric acid, adding 2 c.c. of concentrated acid in excess. Dilute to 400 c.c. with boiling water and add 10 grams of sodium hypophosphate dissolved in a little water and finally 8 c.c. of glacial acetic acid. Boil for 40 minutes. Allow to settle and filter off on ashless filter paper. Wash with hot water and ignite in a porcelain crucible. Cool and weigh as $AlPO_4$.

$AlPO_4$ x 0.2213=Per cent aluminium

THE FOUNDRY DATA SHEET, October 1, 1922
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections 5 x 7 inches, and may be readily bound in note book form.

Changes Design of Electrodes

New Furnace in Steel Plant of Well Known Italian Corporation Has Sealed Electrodes To Prevent Oxidation through Contact with the Air— Lower Voltage Employed for Refining Operation

BY G. VITALI

LACK of pig iron and coal induced the Fiat works in Turin, Italy, to build an electric furnace, which would make possible the economical manufacture of ordinary steel in quantities. For some years in the steel foundries of the Fiat works there were six furnaces of 5 to 6 tons capacity. Results with these were so favorable that in the reconstruction and renewal of the smelting equipment the originally installed Martin furnace was abandoned and a new steel works was erected with four electrical steel furnaces of 15 to 20-ton capacity and two smaller ones of 3 and 6-ton capacity. This electric steel installation later was removed to further increase the four to eight furnaces. Because of its new hermetically sealed electrodes and their unusual efficiency the performances and advantages of this latest furnace should be of interest.

In designing the furnace, Cav. Carlo Masera, of Turin, felt that the following features for a furnace of this type would be desirable:

1. Producing and obtaining an unconditional neutral atmosphere in the hearth space during the entire period of the operation.

2 Using an uninterrupted working electrode, without stopping the process of the furnace or dismounting a part of the sealed electrodes.

3. Obtaining a theoretical period of melting of about 2½ hours up to the finish, and with suitable cold charges.

4. Reduction of the power and electrodes consumed in comparison with other furnaces in present use.

5. Increase of the life of the lining in the crown and the hearth of the furnace.

6. Obtaining the greatest facility in the construction and demolition in order to be able in the shortest space of time to change or alter the crown of the furnace.

Multiphase current is used, it being supplied at 21,000 volts from the Societa Elettricita Alta Italia. The furnace, built by Demag of Duisberg, consists essentially of a cylindrical, well stiffened-plate housing with an arched bottom, in which are two segmental cylindrical railway tracks making it possible to tip the entire furnace in both directions. While some furnaces in the works are operated by a hydraulically-driven tipping apparatus, the newest type is tilted electrically.

The furnace casing and its refractory lining has only two openings, a large port in front for the charging of the material and the removal of the slag, and a smaller one on the opposite side for the tapping of the metal.

Removal of the slag in the manufacture of steel is of importance. When the Fiat furnace is tilted slightly the slag flows off under the charging floor into a stationary but movable container.

Especially noteworthy is the construction of the electrodes of this three-phase furnace. The three graphite electrodes with their auxiliary equipment rest upon a special bridge as in Fig. 1. Each electrode with its equipment including motor, can be exchanged during operation for another electrode in about 30 minutes.

After the bridge has been removed, the cover-ring can be lifted from the arch, so that a removal of the arch or of the lining is possible.

It is said that the excellent results of this type of furnace construction can be traced back to the careful fitting of the electrode packing and the method of cooling. Upon the curved arch there is a double walled water-cooled cylinder which hermetically seals the electrode as illustrated in Fig. 2. To the electrode clamp, whose movement is operated by two spindles automatically driven by a motor, a second cylinder is attached which is telescoped over the cooling cylinder and packed snugly with the electrode. The air-tight packing prevents combustion of the electrodes and tends to give a considerably longer life. The electrode consumption in the furnace is reduced to 2.8 or 3 kilograms per ton of molten steel. With the new type of electrode, a luminous arc appears at the end of the electrode, while at a less distance from the arc the cross-section is reduced but slightly. Since the air-tight packing prevents the flame from going out, it follows that in the interior of the furnace no circulation of the air takes place. Therefore when the charging door is opened, no air is put into circulation. Moreover, it is claimed

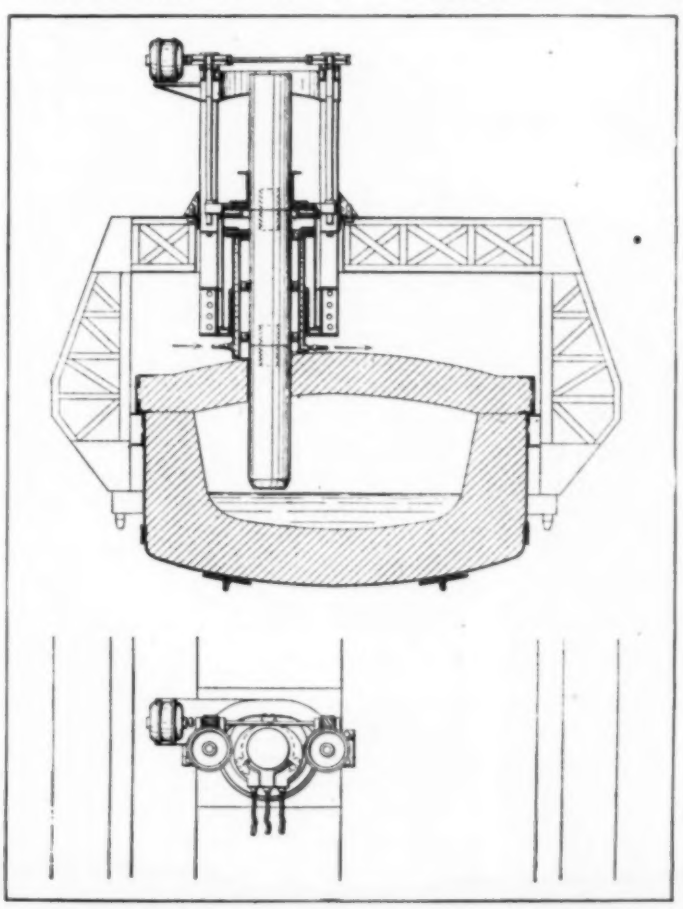


FIG. 1—LONGITUDINAL SECTION OF THE NEW ELECTRIC MELTING FURNACE INSTALLED AT THE FIAT WORKS

Translated and abstracted from *Stahl und Eisen* by Pendleton Powell.

that no heat is consumed for heating the air that sweeps through some types of electric furnaces; consequently the atmosphere over the bath of metal remains constantly neutral or at least reducing. Use of cast iron or any other method of carbonization is almost unnecessary, since the carbon already present in the bath of metal is scarcely oxidized. A small amount of flux is sufficient in order to give the metal a certain amount of carbon.

As to the operation of the furnace the following will be found of interest: As a rule two pressures can be employed—one of 130 volts and a lower one of 75 volts. In the first and longer period of the melting down of the solid charge, 130 volts are consumed, to introduce the greatest

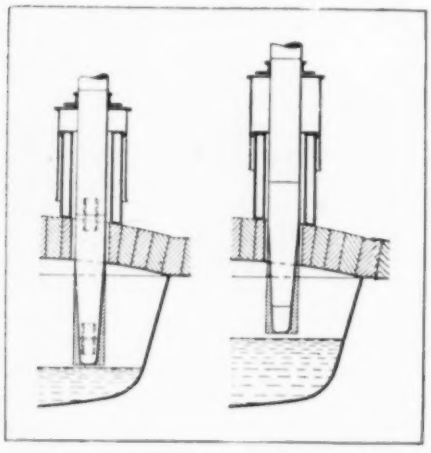


FIG. 2—AN INDICATION OF THE WEAR OF THE ELECTRODE WITH THE NEW PACKING ACCORDING TO THE FIAT METHOD OF CONSTRUCTION

pressure of current possible. For the second or refining period of the melt, 75 volts is enough to bring the molten bath to a pouring temperature of about 1750 degrees Cent. The oil transformer for the 5 and 6-ton furnaces is measured with the triangular connection of the primary circuit for a production of 2000 kilovolt amperes.

The primary circuit is cut in upon the shaft; thus the work is lessened to 1150 kilovolt-amperes. Correspondingly the current in the secondary circuit is transformed into 75 volts. The secondary circuit is connected to the shaft, and for each electrode there are 12 pliable conducting cables, having a total cross-section of 4800 square millimeters. The center point of the shaft is laid in the immediate vicinity of the furnace. Thus the continuity of the equilibrium is disturbed as little as possible, and it is even allowable to start the furnace with only a luminous arc. The furnace floor is covered with earth in addition in order to avoid the destruction of the induced currents and the discharge between the metal parts.

In the secondary circuit only the transformers are inserted for the ampere-meter for the regulation or adjustment of the arc and for the automatic regulator. All other units for measuring, control, registering, and safety apparatus are in the primary circuit. To obtain the utmost possible short transmission the entire transformation plant is placed in the space which is under the charging floor.

Some operation results are stated as follows:

1. Tapping—Charge of 4675 kilograms:

	Hours	Minutes	Kilowatt hours
First period..	2	5	2550
Second period	0	43	650

2. Tapping—Charge of 4675 kilograms:

	Hours	Minutes	Kilowatt hours
First period..	2	7	2450
Second period	0	48	670
Altogether..	2	55	3120

3. Tapping—Charge of 4675 kilograms:

	Hours	Minutes	Kilowatt hours
First period..	2	2	2500
Second period	0	33	500
Altogether..	2	35	3000

The total current consumed, therefore, during these tappings has amounted to 9320 kilowatt-hours or with a charge of 4675 times 3 which is equal to 14,025 kilograms on the average of 0.66 kilowatt-hours per kilogram. It is to be observed that with these and all the following measurements the indicator in the primary circuit were inserted. All the loss in the transformer and in the secondary circuit with its apparatus therefore is included in these combustion figures.

As a monthly average it follows that with a total quantity of 1,341,160 kilograms of cast steel and a current consumption, measured by the recorder of 937,000 kilowatt-hours there was a mean current consumption of 0.68 kilowatt-hours per kilogram of cast steel. With this it is to be remembered that no castings were made during the holidays, although the furnace remained alive with the current, and this current so lost is contained in the preceding figures.

Patents Powdered Coal Equipment

To lessen the oxidation losses in melting malleable iron in an air furnace fired with powdered coal the Grindle Fuel Equipment Co., Harvel, Ill., has designed and patented a furnace having burners which enter directly into the chamber containing the hearth, and in such a manner that the flame creates a circulating motion in the bath. This is done to bring all parts of the bath to a high temperature rapidly.

This construction was first put into operation in 1919 and has since been installed in other malleable iron foundries. The company recommends the use of its system of powdered coal, not only for melting furnaces, but for core ovens and annealing ovens.

Extends College Service

During July and August, R. E. Wendt of the engineering department of Purdue university, Lafayette, Ind., visited 57 foundries in Indiana and interviewed 100 foundrymen in an effort to assist in the solving of foundry problems. Mr. Wendt who has had extensive practical experience is in charge of the foundry department of the university. The trip was arranged in connection with the engineering extension work offered by the school. As a result of Mr. Wendt's visits, many of the foundrymen announced themselves in favor of holding a conference at the university next spring. A number also expressed their willingness to take students into their plants during the summer vacation period.

Completes Sea Coal Plant

The Consolidated Foundry Supply Co., 30 Church street, New York city, recently completed a sea coal facing plant at Wyano (near Irwin), Pa. The plant is built immediately adjoining 220 acres of high grade Youghiogheny gas coal, which furnishes an inexhaustible supply. Shipping facilities are provided over the Pennsylvania and Baltimore & Ohio railroads, and on these sidings eight cars can be loaded at a time. The capacity is 200 tons per day.

Opens Large Sand Pit

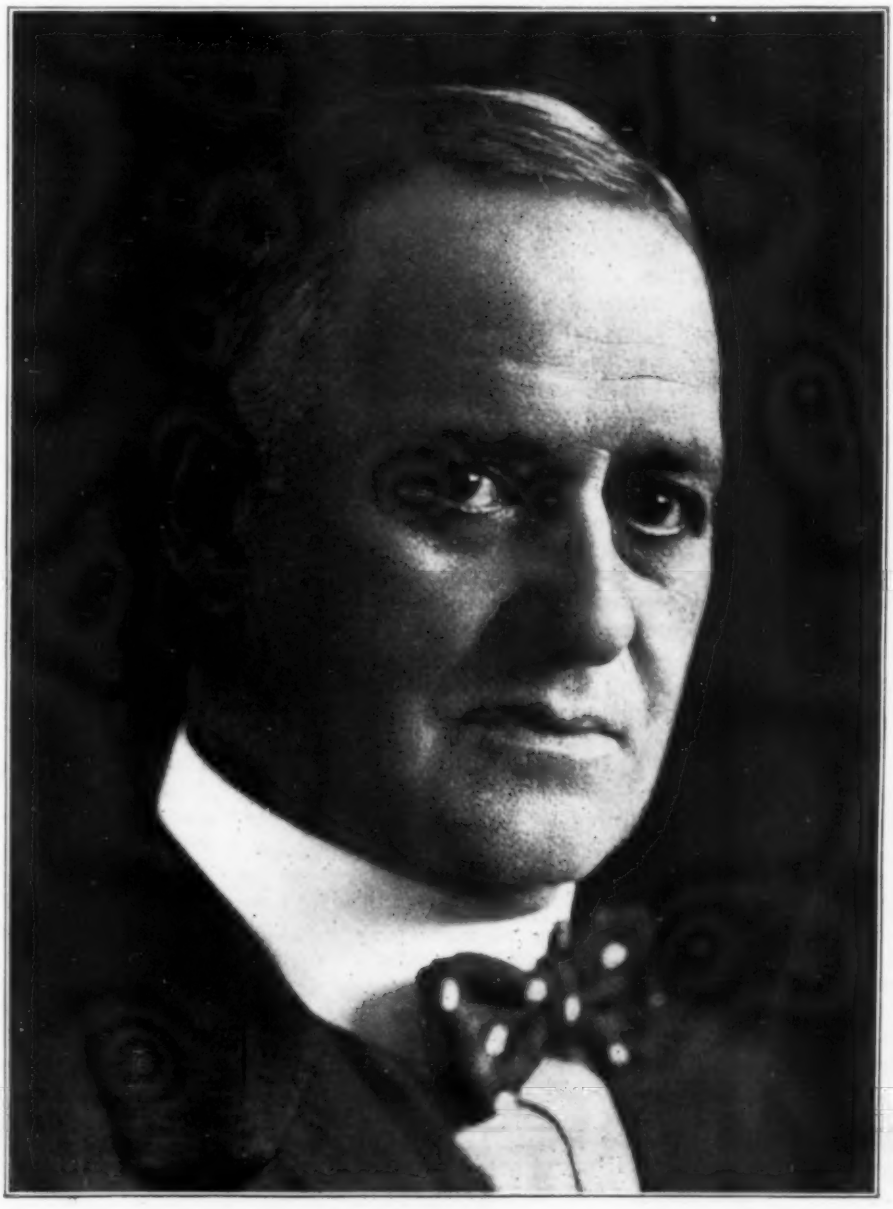
The Northern Refractories Co., whose main office is located at Ridgway, Pa., has opened up an enormous tonnage of a loosely agglomerated sand on its property at Hutchins, McKean county, Pa. This sand contains a natural bond and when milled and screened to size forms a molding sand for gray iron. Test shipments have been made to several foundries and the company has prepared to handle a large monthly tonnage. On account of the nature of the original sand and the low percentage of moisture present the company expects to be able to ship at any season of the year.

The Norwalk Iron Works Co., South Norwalk, Conn., has merged with the Automatic Carbonic Machine Co., Peoria, Ill., the plant and equipment of the latter being moved to South Norwalk.

John P. Pero, Malleable Foundryman, Is Dead

JOHN P. PERO, recently connected with the Canadian Steel Foundries Co., Ltd., Montreal in an advisory capacity, died at the age of 66, on Sept. 23 and was buried on Tuesday Sept. 26, at Indian Orchard, Mass. In December 1919 Mr. Pero retired from active work, at that time having rounded out fifty years of colorful participation in the foundry industry and eleven years continuous service as general superintendent and sales manager for the Missouri Malleable Iron Co., East St. Louis, Ill. Thirty years had been spent in the gray iron field and the remaining twenty in the malleable iron industry where he was acknowledged as an authority not only on all phases of the technical and manufacturing end of the business, but also in the promotion of a wider market for malleable castings, through educating the buying public Mr. Pero, was born in Waltham, Mass., Dec. 9, 1856, the oldest member of the third generation of a family, all of whom attained prominent positions in the New England foundry field. He attended the public schools of Waltham until he was 9 years old and then the family moved to Worcester, Mass., where he attended the public schools of that city until he was 13 and had entered on his third year in the public high school of Worcester. His subsequent education was secured in the hard but efficient school of practical experience and a diligent application to the study of men, events and problems incident to his chosen calling. On Feb. 1, 1856 he was indentured as an apprentice molder and in the succeeding 12 years he gained an enviable reputation as a skilled mechanic on heavy castings in various New England cities including Worcester, Springfield and Fitchburg. In 1882, the young journeyman, then in his 26th year accepted his first position as a foreman molder. Since that time he has been prominently identified in the management of some of the leading foundries of New England and the Middle West, including such representative shops as Yale & Towne Mfg. Co., Stamford, Conn.; Malleable Iron Fittings Co., Branford, Conn., and the Missouri Malleable Iron Co., East St. Louis. He introduced many innovations and methods of control tending to improve malleable practice and to raise the quality of the castings to the high plane at present maintained throughout this great industry.

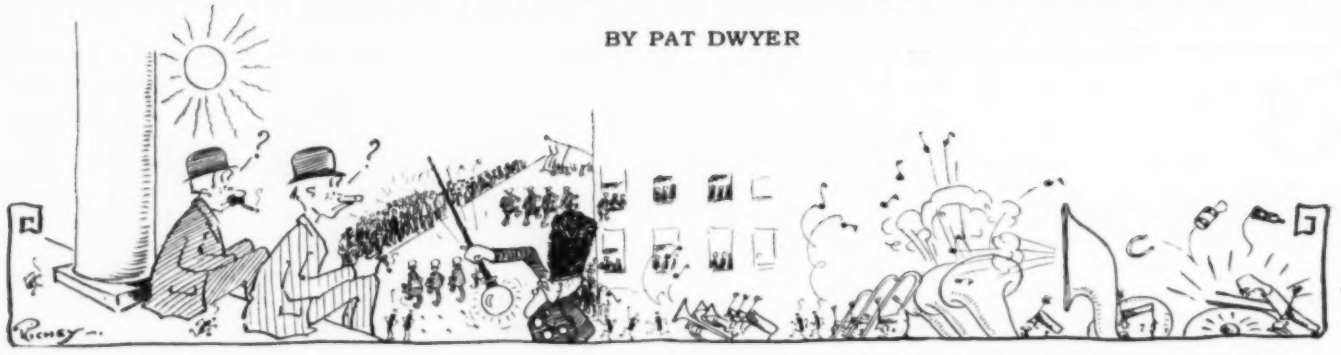
Mr. Pero always was deeply interested in promoting educational work along foundry lines and in 1887 conceived the idea of forming an association among foundrymen with the object of promoting an exchange of views on technical and practical subjects connected with foundry practice. To that end he was instrumental in organizing the New England Foundry Foremen's association, believed to be the original American association devoted to educational work among foundrymen. He served as secretary of this association for a great many years and in addition to his regular work was a frequent contributor to trade journals on subjects connected with the foundry. Mr. Pero was one of the original members of the American Foundrymen's association, always active in promoting and extending the scope of its influence and was a director since its inception. He served as president in 1916 and his work while in that office was of such an outstanding and valuable character that he was unanimously re-elected to the same office for the 1917 term. One of Mr. Pero's first acts after going west was to organize a foundry foremen's association in the St. Louis district to promote educational work, exchange of views and general good fellowship among foundrymen. Mr. Pero is survived by one son J. P. Pero, Jr., and three daughters.



JOHN P. PERO

Bill Discusses Pulley Molding Problems—V

BY PAT DWYER



PERCHED a few days ago on what the nimble fingered authors of our best sellers are wont to refer to as a coign of vantage—the same in this instance being the top step leading into a down town bank—Bill and I spent an interesting hour watching a parade go by. Neither of us knew a single individual in line personally and indeed we only had a slight newspaper knowledge of the others. More for the sake of stirring Bill up than because I entertained any settled convictions on the subject, I intimated that the parading business was overdone and that really it meant nothing after all. I claimed that a person could stand on the same step we were on any day in the week and almost any hour in the day, provided some officious porter or policeman did not order him to move, or run him in, as the case might be, and probably would see just as many human beings hurrying past in a given time. Because they have no flags, uniforms or bands, no one pays any attention to the usual daily traffic jam.

Some peculiar feature about a parade attracts a man's interest and curiosity. For some the attraction is stronger than for others and a few never are so happy as when they have the opportunity to drape some form of distinguishing garment around their person and to walk down the middle of the main street, either in their own, or any other town. A street by any other name smells as sweet on a hot day, to a parade fan.

Others are content to stand on the side lines and watch the more or less orderly procession file past. I asked Bill if he ever stopped to consider that these two parties are necessary, one to the other. Together they make up a harmonious combination, but separately, neither would amount to a pinch of snuff. I suppose if I had stopped to think I would have realized that the simile was rather far fetched, since that dear old smelly, sneezy habit practically is obsolete and I rather expected that Bill would direct my attention to the fact. However, he said nothing and I continued to the effect that if there was no parade, people would not stand like a flock of penguins, lining the curb for hours on both sides of the street. On the other hand if the people on the sidewalks, the non-paraders, ceased to display any interest, the marchers' enthusiasm soon would evaporate. I can imagine nothing more pathetic than a band of gaily caparisoned lads all tricked out in fancy costumes marching through the streets of a town where no person on the sidewalk paused for an instant to admire them or, even gave a momentary glance.

"If you have any time to spare", said Bill "it is a wonder to me that you do not occupy it with speculating on some subject within the bounds of probability. I have heard many descriptions defining the height of foolishness, but when I hear a man worrying over something that never is going to happen, I feel convinced that he has reached the peak, the pinnacle, the top-notch of simplicity; that senile decay is well under way and that he is on the way to squirrel town. Men always have paraded and always will and just as surely as it affords them a certain amount of pleasure to go high stepping down the street, so other men and women will continue to derive pleasure from standing on the curb and watching the show. Besides, in these modern days, there always is the chance that one's face may be visible when the picture of the parade is flashed on the screen in the neighborhood theaters a few days later.

"History principally is made up of stories of parades of one kind and another, including that one described so musically—if a trifle at variance with the well known antipathy of wild animals for each other—in the old camp meeting hymn dealing with Noah and his ark. Do you remember how the animals went in three by three, the bear, the bug and the bumble bee and later, along in the arithmetical progression, the ant causticalally inquired if the elephant knew who he was shovin'? In that instance it is true that our humble four-footed friends—and some that are neither four nor two-footed and not so humble—did the parading; while Noah and his wife and his three sons and their wives, sat on the rail and did the cheering.

"I am not a farmer and do not pretend to any intimate knowledge on the subject of caring for live stock, but I owned a family of rabbits at one time and basing my opinion on the experience I gained at that time, I think I am quite safe in making the assertion that Noah and his wife and his three sons and their wives, cheered much more lustily—threw more heart into it as it were—when they saw the tail end of the parade leaving the ark on Mount Ararat, than on the day several weeks before when the first of the motley gang marched up the gang plank.

"A few months ago in Richmond, Va., during the week of the Confederate Veterans Reunion, I had an opportunity to witness a parade that gave me more pleasure than any other of the many I have seen since that far away day when I stood near Riverside Drive in New York and listened to the cheering that welcomed Admiral Dewey home from the Phillipines. That was an impressive spectacle, but it lacked the spontaneity, the enthusiasm, the whole hearted sympathy and co-operation between the spectators and the paraders, that characterized the recent event in the one time capital of the Confederacy. Many of the features were familiar, the local National guard in their fancy uniforms, shakos and nodding white plumes; middle

ANSWERING CIVIL QUESTIONS IS BILL'S SPECIALTY

aged veterans of the Spanish war in olive drab and young, alert bright eyed veterans of the world war in kahki, but, the veterans in gray added a distinctive touch I never had seen before.

"Many of these men through age and infirmity and others, in deference to the entreaties of solicitous relatives, consented to ride in automobiles, but a surprisingly large number, animated by the old fighting spirit that in their lusty youth carried them through the hardships and privations of four crimson years, insisted on walking. Spectators cheered the survivors of the various historic regiments as they went swinging past, but when the handful of men who represent all that is left of the famous Louisiana Tigers came into view, followed by a remnant of that dashing bunch of young dare devils once known as Forrest's cavalry, the lid blew off with a bang and the crowd reverted into primitive human beings who saw no reason why they should not indulge their emotion in any way they saw fit. Men shouted and cheered and threw their hats in the air, children were lifted shoulder high to see a sight that would stay with them and serve as an inspiration to the longest day they lived. Women and girls waved flags frantically and those that were not openly weeping were screaming hysterically.

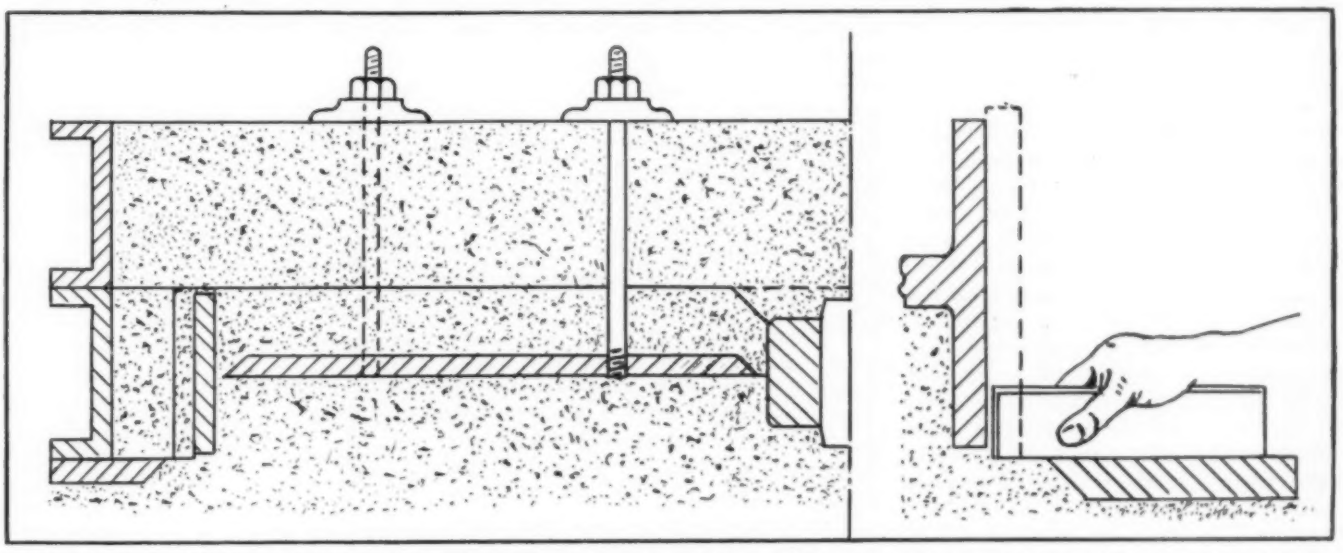
"I am not from the South, my father and one of his brothers served in the Union forces during the Civil war, one in the army and the other in the navy and therefore no valid reason existed why I should wave my hat and cheer with the others. Neither apparently was there any good reason why I should feel my throat contracting and a stinging sensation in both eyes.

"However, looking back at it now I can't say that I feel ashamed either at what I did, or how I fe't. The sight of these old, old men, many of them withered and stooped, not dressed in the smart, official gray-blue veteran uniform, but dressed in the old Southern gray of 60 years ago, with blanket roll and haversack strapped on their backs, service caps in many instances cocked at a jaunty angle over long, streaming white hair, with rifles carried smartly at *shoulder arms* and marching behind a war worn and weather beaten silken banner, powder stained and shot to ribbons, was enough to electrify anything short of an Egyptian mummy. Without waiting to ask itself why, or to analyze its feelings, the crowd drew on the everlasting springs that keep courage and justice and truth alive and yielded tribute to these virtues impersonated by men who had fought for a principle".

"I'll have to admit" I said "that you have made out a fairly good case for parades and why they should be continued; but if I am not unduly inquisitive and if the question does not involve any breach of confidence, might I inquire what you were doing in Richmond during the festive season?"

"No harm in the world in asking a civil question," said Bill. "I shall be equally civil, frank and free in answering you to the effect that what I was doing in Richmond is none of your business. I think you are the nosiest individual I ever met, with the possible exception of a gaffer for whom I worked at one time in a little shop down east. He hated to make a job the same way twice and never was really happy unless he was trying out a new job or making an old one in a new way. He was the first man I ever saw making a pulley mold that was wider in diameter than the pattern. I had seen rings lagged on the inside and also on the outside, principally with the object of providing more *finish*, but in both instances the ring simply was made thicker than the pattern. The pulley I have in mind, an old casting 8 feet in diameter, with a 12-inch face, 1-inch thickness of rim, was used as a pattern and naturally the mold had to be 2 inches larger in diameter to compensate for the contraction.

"Cast iron contracts ⅛-inch to the foot under ordinary circumstances and while this contraction can be provided for on small castings by a little extra rapping, in the case of large castings made from originals, provision for contraction must be made in some other manner. A row of lagging strips 1¼-inch thick, set close together, vertically, around the outside circumference of the pattern solved the problem of increasing the outside diameter, but how to maintain the 1-inch thickness of rim was the factor that made the job interesting. The customer could have written or telegraphed the pulley people and had a new wheel shipped for a lower price than the local man charged, but this happened to be one of those emergency jobs where time is the only factor to be considered.



LEFT—VIEW OF ASSEMBLED MOLD WITH PATTERN AND LAGGING STILL IN PLACE RIGHT—METHOD OF MAKING PARTING FOR LAGGING STRIPS

"The mold might have been made in one of several ways, but the fact that a round flask, a lifting ring and a set of plates for lifting the sand between the arms were available, automatically decided which plan to adopt. The lifting ring was rapped down on a level bed and the space on the inside of the ring filled with sand which was butted and then scraped off flush with the upper surface of the plate. The iron pattern then was lowered into place, centered and supported on several pieces of ¼-inch plate. The pieces of plate were scraps from the boiler shop of no particular shape and were employed to provide ¼-inch stock on the lower edge of the pulley rim for

cleaning up. They held the pattern ¼-inch above the lower parting line until sufficient sand had been rammed under the arms and hub to support the weight, then they were withdrawn.

"The inside of the mold was rammed in the usual manner and a parting was made along the center line of the arms. Parting sand was sprinkled over the surface and an individual lifting plate was set between each pair of arms. Lifting bolts, long enough to extend above a cope, were screwed into the plates and then the remaining space inside the pattern was filled with sand, butted and scraped off a little higher than the rim of the pattern.

"A parting was made on the outside ¼-inch lower than the bottom edge of the pattern, or in other words in a straight line with the upper surface of the lifting ring. Parting sand was sprinkled on the narrow strip of sand exposed between the ring and the pattern and then the drag part of the flask was placed in position around the pattern. A row of lagging strips each piece 12½ x 1¼ x 1 inch was set vertically around the exterior of the pattern. Riddled sand shoveled in behind them held the pieces in place until the entire ring was completed. From the foregoing it will be noted that the lagging extended ¼-inch below the pattern and the same distance above, also it was set against the pattern in such a manner that the radius of the wheel was increased 1¼ inches. The extra ¼-inch in each case being provided for finishing.

"The space between the flask and the lagging was rammed full of sand and then a parting was made flush with the top of the lagging and extending from the center to the flange of the flask. Gate pins and risers were adjusted on the hub where a small parting had been made and then a cope was set on and rammed full of sand. After the nuts on the lifting plate bolts were screwed down firmly, the cope was lifted off and set down on suitable stands until after the pattern had been drawn. The cope then was returned to place, the nuts and washers removed from the bolts and the cope once more lifted, but this time without the body of sand comprising the interior of the mold immediately above the arms. The rim face of this body both above and below the arms was scored with a long lifter and then riddled sand was rammed into the space between the body of sand and the lagging which had not been disturbed. No attempt was made to make a parting along the center line because the sand above the arms was not to be lifted again.

"The lagging strips were pulled out one at a time with a pair of pincers instead of the usual wood screw and then the cheek part of the mold was lifted off and placed on stands where it was slicked, blackwashed and skin dried. Loose boards were placed over the parting left by the lifting ring and then the inside face of the mold was patched and slicked. A handful of cotton waste had been placed in the outer end of each arm opening before the mold had been closed. These patches of waste now served to locate the openings and after they had been removed, the openings were trimmed and finished into the proper shape.

"Usually the interior face of a mold of this character would not have been dried but on account of the unusual features connected with the molding, and also because of the time factor involved, it was considered advisable to insure the mold by a thorough drying. An oil torch was employed for the purpose. A wood fire served to dry the cheek of the mold which was covered with long strips of corrugated iron during the drying process. After the mold was dried the cheek was returned to place and guided into the proper position by stakes which engaged four lugs on the outer circumference of the lifting plate. The cope then was set on, the runner basin made up and the mold weighted for pouring. Before the cope was lowered into place, the upright bolts were removed since they no longer were needed.

"The casting was poured from a half and half mixture of pig iron and good machinery scrap and although no analysis actually was made, it would approximate about as follows: Silicon 2.25 per cent; sulphur 0.08 per cent; manganese 0.70 per cent; phosphorus 0.40 per cent. The hub was fed after it was poured and the core was dug out of the center after the metal had set. The mold required a little longer time to make than one made under routine conditions, but the casting represented a finished piece of work and checked up to the necessary dimensions in a gratifying manner. Now the same idea can be adapted even where the available rigging consists of a ring and a set of arm cores and also furnishes a pretty exercise where it becomes necessary to decrease the diameter of a pulley from that of any given pattern."

"It may be a pretty exercise" I said "but I have had all the exercise I want for one day. You may count me out of anything further."

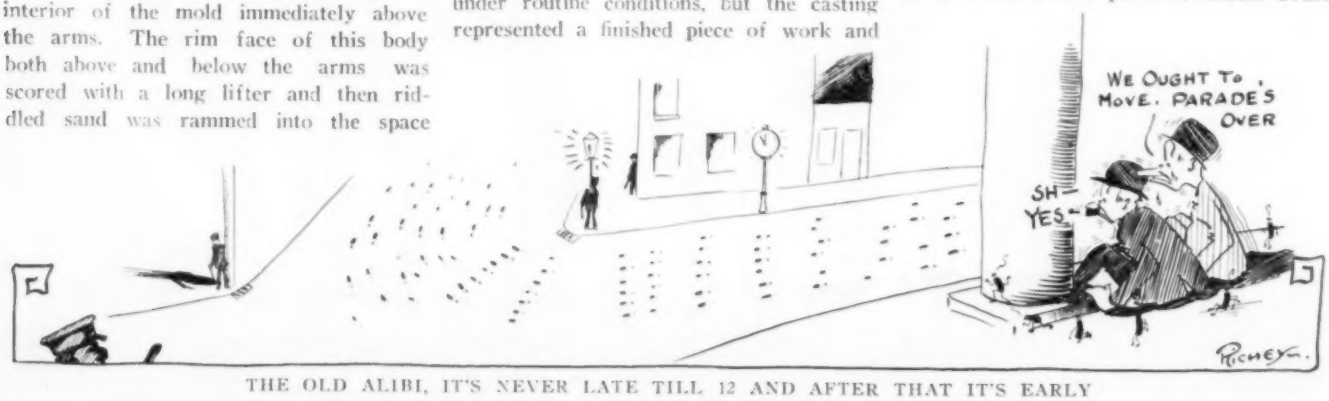
"Exercise!" says brave Bill "Say, young fella, me lad, let me tell you something, if you don't do a little more exercising than you have been doing lately, you will find yourself one of these days leading a one-way parade. You won't be with it on the return journey."

Dirty Iron in Flywheels

By H. E. Diller

Question:—We are making a motorcycle flywheel 8¼ inches in diameter and 6¼ inches inside of the outside rim, with two balance pockets—the crank throw being bossed in two places and irregular in shape. The flywheel weighs about 14 pounds. We have made these castings from both loose and plated patterns, using snap flasks with bands, and with cast-iron jackets in pouring. We have poured the casting on center with horn sprue. We have pro-gated it and have gated it on the rim, both top and side, with strainer cores and without strainer cores. We have obtained our best success pouring this casting from the side through three small gates through a core, but have had a great deal of trouble because the castings were dirty.

We have considered the possibility of our iron being wrong but, as castings poured from the same heat have been entirely satisfactory and castings off the same floor are good, we believe the difficulty is caused by the way in which the molder pours the casting. We have watched skimming the ladle closely and have used special fluxes. In fact we have obtained an excellent casting except for the dirt which seems to be in spots around the rim. Our mixture runs about 40 per cent scrap and 60 per cent pig. The iron contains 2.25 to 2.75 per cent silicon. Could



THE OLD ALIBI, IT'S NEVER LATE TILL 12 AND AFTER THAT IT'S EARLY

you tell us how to overcome the difficulty?

Answer: The trouble seems to be in not having the iron hot enough. In all cases the iron should be at a high temperature when poured. The composition of the iron also will help to give you a solid casting. Silicon in the iron as it comes from the cupola should be approximately 1.8 per cent. The phosphorus should not be over 0.5 per cent, manganese should be between 0.5 and 0.7 per cent and sulphur should be below 0.12 per cent. A good way of gating such flywheels is at the hub. One or two pop risers on the rim would be of assistance.

Making a Pulley from a Part Pattern

BY M. E. DUGGAN

WHERE only one or two large pulleys are required a complete pattern usually is prohibitive on account of the cost. However, several other methods of making the mold are available including the one shown in the accompanying illustration. In the skeleton segment, Figs. 1 and 2, *A* is a piece shaped to the outside circumference of the desired pulley. The segment may be made to any convenient arc of the circle, but usually is made from 2 to 3 feet long. The width at *A*, Fig. 1, represents the width of the pulley face. *B* forms a connection between the rim *A* and the center *C*. A turned wood pin may be employed for a center at *C* on comparatively small wheels, but on large jobs it is necessary to provide a steel spindle inserted in a suitable hole in the end of the arm *B*. The braces *D, D*, which of course may be attached in many ways besides the one outlined, serve to hold the segment *A* in its proper position.

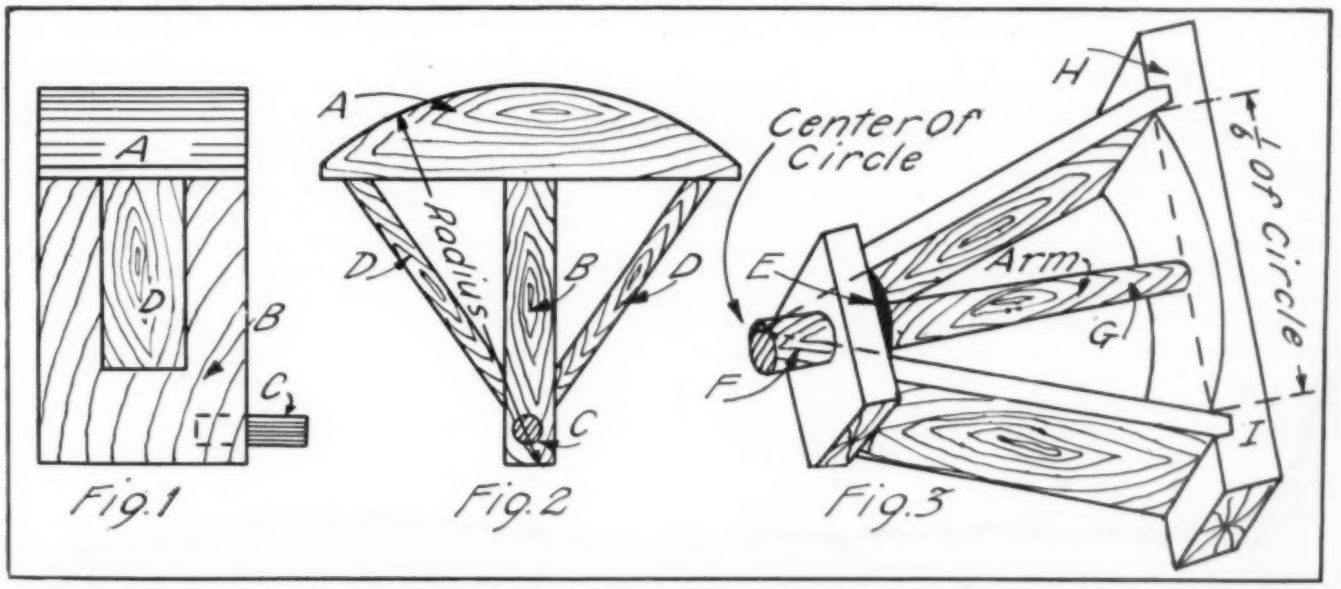
The corebox shown in Fig. 3 is designed to produce a core that will occupy a definite amount of space in the interior of the pulley mold. Thus if the pulley has six arms, the core will take up one sixth of the space, if four arms, one fourth, and so on. Assuming that the pulley is to have six arms the corebox will be made as shown in Fig. 3. It is made in the shape of an open frame which can be taken apart readily and reassembled again. The arm *G* conforming to the shape of the desired pulley arm, is located by suitable openings, one in the inner and the other in the outer end of the corebox. It is made to project at the inner end *F* so that it readily may be grasped and pulled out after the corebox has been rammed full of sand. With this type of construction it is necessary to cut the fillets on the ends of the arms in the sand after the corebox has been removed. An alternative method by which the arm would leave its own fillets in the sand would be to form the arm pattern in three parts. A short filled part is attached permanently to the interior center of each end, and a long, straight piece held between the two end pieces by suitable dowels. After the core is rammed, first one end and next the other end of the corebox is removed horizontally, and then a long wood screw is employed to pull the center section of the arm out of the core.

Cores may be made either in green or dry sand. In the event that green-sand cores will suit the requirements of the job in hand, it will be necessary to provide a lifting plate, or a good grating for each core. The plate or grating, provided with four suitable loops extending to the upper face of the box, is placed in the bottom of the box before the latter is filled with sand and rammed. Dry-sand cores, if necessary, may be made without either grating or plate. A number of rods disposed according to accepted coremaking practice will furnish all the necessary reinforcement.

The outer wall of the mold is formed, either in a pit in the floor or in a flask, by ramming sand behind the segment, Figs. 1 and 2. The sand is rammed to the top and then the segment is moved around a short distance and the operations repeated until the circle has been formed. The cores are lifted, one at a time, and adjusted in the mold by measurement after which the hub and rim are covered with a number of flat cores, or by a flat cope.

French Foundry Meet

The annual convention of the Association Technique de Fonderie is fixed to take place at Nancy, France, on Oct. 5 to 8. The details of the arrangements are not yet made public, but a great deal of interest is being taken in the gathering and a good attendance is expected. A number of technical papers are to be given, to be followed by discussions. Arrangements have been considered for the International conference which is to be held in Paris next year, in accordance with the wish expressed at the recent foundry exhibition and conference in Birmingham, England.



THE AMOUNT OF PATTERN MAKING REQUIRED ON AN OCCASIONAL PULLEY OR WHEEL OF THAT CHARACTER IS REDUCED TO A MINIMUM BY USING A SKELETON PATTERN

Three-Part Molds Advocated

Advantages Claimed Are Increased Number of Patterns in the Flask, Better Arrangement of Gates and Runners and Elimination of Time Consuming Methods in Preparing the Mold

BY WILLIAM H. PARRY

ADVISING the use of 3-part flasks in the making of castings usually molded in 2-part flasks, on first thought, may appear absurd. However, conditions incidental to the rapid production of sound castings, for example, those that have to withstand severe pressure, tax the ingenuity of the most expert foundryman. In the opinion of the writer many of the difficulties may be overcome by employing the 3-part mold. With the almost universal use of production pattern plates it is not unusual to find that such plates do not always produce as many good castings as the number of patterns

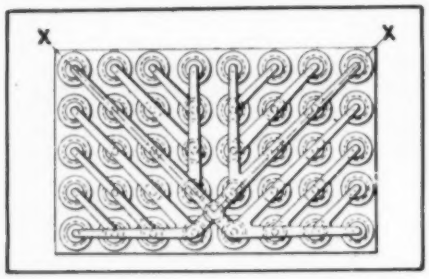


FIG. 1—SECTION OF 3-PART MOLD ASSEMBLED THE SECTION IS ON THE LINE *XX*

would seem to warrant. In fact instances are not unknown where not a single good casting has been found after the mold is shaken out. It is not claimed that improper gating in all cases is the cause of these failures, but without question it is an important contributing factor. It is not always good policy in designing production pattern plates to crowd as many patterns as possible into the flask space with the idea of increasing production. Frequently under such conditions the result is exactly the reverse of what is expected.

A staggered section of a three-part mold assembled, showing the sprue and runner in the cope, the pop gates and the upper part of the castings in the cheek, and the lower part of the castings in the drag is shown in Fig. 1. Fig. 2 shows the position and number of patterns on the plate or plates and the arrangement of the runners and gates. Fig. 2 is a section of Fig. 1 on the lines *x-x*.

It will be noted that apparently this is a simple two-part job. At first, the

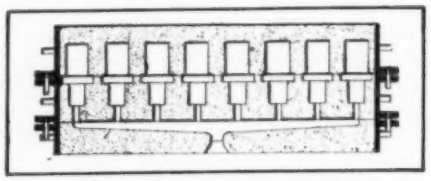


FIG. 2—PLAN VIEW SHOWING ARRANGEMENT OF PATTERNS AND RUNNERS

work was planned for a two-part mold with gates attached to the flanges and two longitudinal runners. The castings were to withstand a hydrostatic pressure of 1000 pounds per square inch after being finished all over, and hundreds of thousands were needed. Every casting produced in this manner was porous and therefore it was evident that some other method of gating must be tried.

Pattern plates were made by the dozen each embodying some new method, but they all failed. Finally, a mechanic not connected with the foundry force, sugested the three-high idea. When he tried to explain how a two-part job could be made better in three boxes of sand, he was considered insane; nevertheless in desperation the foundry management tried his scheme. It succeeded beyond even the wildest hopes of the man who suggested it.

Three plates were made, the runners

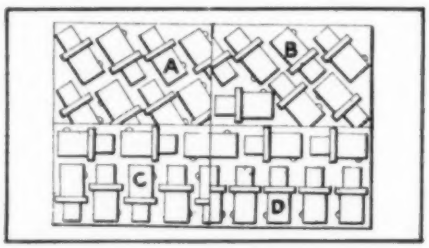


FIG. 3—FOUR QUARTER LAYOUTS SHOWING ARRANGEMENT WHERE SPLIT PATTERN PLATES ARE USED

and about one half of the sprue were attached to the cope plate, as shown in Figs. 1 and 2. The cheek plate carried the patterns for the upper parts of the castings and the drag plate carried the remaining sections of the patterns. Pop gates were attached to each of the 40 patterns, projecting upward just high enough to come flush or a trifle under the upper surface of the cheek and engaging with the runners at points shown at Fig. 2. The sprue was so placed that the inrushing metal did not pour directly into one casting cavity, while the runners were designed to give the most direct passage to the metal.

Tight flasks were used and it was possible to pour 40 sound castings to each mold. This was 17 in excess of the number of patterns spaced on the two-part flask plates as originally designed, and from which not one casting free from porosity was obtained.

One decided advantage in using the elevated runner method is that no attention need be paid to the runner or gate positions in placing and spacing the patterns other than to keep in mind that they must not be staggered so that the runner shape departs from easy flowing

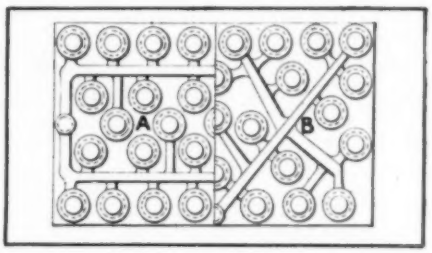


FIG. 4—TWO HALF LAYOUTS SHOWING USUAL ARRANGEMENT OF GATES AND RUNNERS

lines. However, a fair variation from a straight line is allowable. Again, this method lends itself to direct pouring into the casting cavities and provides feeders to counteract gravity shrinkage in castings with heavy and deep sections on each side of a light flange.

On the original two-part flask plates the gates engaged the flange so that the metal first flowed down then up in the cope. The upper hubs did not always fill, and when they did, sponginess was to be found at the junction of hub and flange.

In Fig. 3, *A*, *B*, *C* and *D* show four quarter layouts of a similar piece on split pattern plates, half on each side. The illustration indicates that many patterns may be placed on plates without any attention being paid to gates and runners, as they would be provided for in the cope of a three-high mold. If the layouts as at *A*, *C* and *D*, Fig. 3, are followed, 28 castings are possible, while if *B* is employed 26 can be obtained. This is at least eight in excess of what could be expected from the two-part flask method.

This well repays the extra labor of ramming up a shallow cope to form the

From a paper presented at the convention of the American Foundrymen's association at Rochester, N. Y.

overhead runner. Pop gates are not shown on these layouts, though they can be placed on either hubs or flanges, their position at times being determined by the ease with which they can be separated from the castings or located so that the following machining operations will remove all evidence of their presence.

In Fig. 4 the two half layouts *A* and *B* show the antiquated runners and gates usually employed to coax the metal into a two-part flask mold in an attempt to get sound castings. Layout *A* provides for a barely possible maximum of 33 castings with a chance of losing one-third, while layout *B* can be crowded to account for 29 with a fair chance for a 25 per cent loss. The estimated loss percentages are in favor of layout *B*, because of the shorter run of the metal and the likelihood that some of the cav-

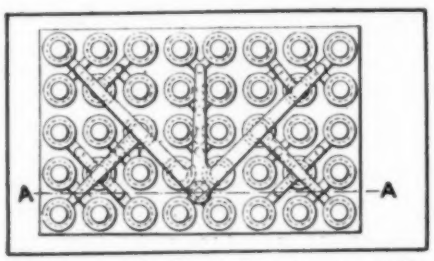


FIG. 5—MIDWAY GATING TO THE FLANGES

ities in layout *A* will be filled with air only.

Fig. 5 is a layout of midway gating to the flanges, the metal being fed from the top runners located in the cheek and through uprights shown in section at Fig. 6. No great advantage in using this method is apparent other than that it may prove convenient on work that must be poured into the midsection of the casting.

Fig. 6 is a section of Fig. 5 at *AA* and illustrates the possibility of feeding 40 castings with only 16 upright feeders. This arrangement is of rather dubious advantage, but it can be adapted to some classes of work. Fig. 7 serves to illustrate how bad a runner layout can be to offset the virtues claimed here for overhead or bottom pouring.

It will be noted that 41 castings are expected from this plate. This number is obtained by crowding as many patterns as possible within a prescribed space, regardless of future consequences. Nevertheless, with all the crowding, there are seven waste spaces—*A*, *B*, *C*, *D*, *E*, *F* and *G*—which could be utilized as in Fig. 2, where the runners are laid out so that a mass of metal will not form at the sprue position as in Fig. 7. This condition, as illustrated in Fig. 7, is likely to create serious trouble when cooling.

Fig. 8 shows how bottom pouring is made effective without horn gates. Bottom pouring is no more expensive than the ordinary method and is successfully

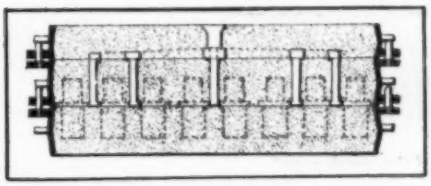


FIG. 6—SECTION THROUGH *AA* FIG. 5

employed on pressure work. Note how the sprue passes through the cope and cheek feeding the runners, gates and 40 castings just as easily as the old-fashioned horn gate fed one casting. As a matter of fact, it is easier by this bottom pouring scheme to make 40 or even a 100 castings than one with the horn gate. This may appear to be a wild statement, but on analysis it develops that the handling of a single horn gate to place in correct position, or near it, and keep it there, involves molding skill of a high order. Moreover much time is consumed in the operation. The delicate job of curving out the gate, while simple enough, requires an excessive amount of time.

On the other hand, with a three-part mold, a man with a machine, proper flask equipment, and good pattern plates can ram two or three complete molds (40 castings to a mold) and can pour them off before the man using the horn gate method closes down his one mold containing a single casting.

In giving publicity to a scheme that

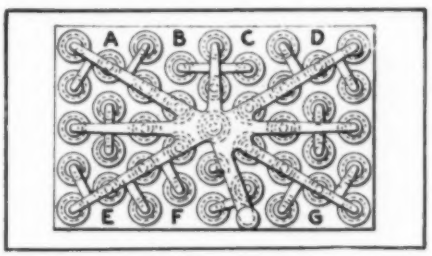


FIG. 7—AN ARRANGEMENT BY WHICH SPACE IS LOST AT *A*, *B*, *C*, ETC., DESPITE CROWDING AT OTHER POINTS

involves the ramming of an extra flask, be it ever so shallow, to pour castings that are usually made or spoiled in two-flasks the writer is not unmindful of the doubt that will be expressed by many readers. Nevertheless, in spite of the extra labor and the expense of increased flask equipment, this method will succeed in making sound castings at less cost than any other known method. It will be noted that no mention is made of risers as part of any of the three proposed

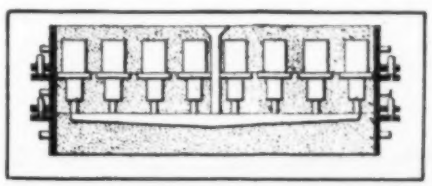


FIG. 8—APPLICATION OF BOTTOM POURING METHOD WITHOUT THE USE OF HORN GATES

methods, that is left to individual taste. A closer study of the bottom pouring system, as shown in Fig. 8, would indicate that risers taken off each casting would insure better work.

Another objection that may make some foundrymen hesitate before adopting this method is the extra labor entailed in separating the castings from the gates. A little study discloses the simple solution, which is to first cut through the runners, lay the casting on their sides, and cut through the gates. This method applies to nonferrous castings, gray iron castings can be knocked off.

It is but fair to state that snap molds cannot be expected to give results comparable with those of tight flask molds. The binding qualities of stiff metal flasks permit the placing of more patterns on a plate with a greater factor of pressure resisting safety, than would be posible with snap molds even when pouring jackets are used.

Submit Coke Standards for Approval

The American Society for Testing Materials has submitted its standard methods of laboratory sampling and analysis of coke to the American Engineering Standards committee for approval as a tentative American standard. These methods were formulated by a committee of the society in cooperation with the American Foundrymen's association, the United States bureau of mines, and the American Chemical society. The specifications are such that methods of coke analysis conform as far as possible with methods of coal analysis, making due allowance for the differences of procedure that are desirable in the analysis of coke.

The American Engineering Standards committee is desirous of learning the extent to which these specifications are used and it desires to receive any other information regarding the extent to which the specifications meet the needs of the industry.

Modernizes Foundries

The International Harvester Co., Chicago, is reported to be giving unusual attention to the foundry departments in its many plants throughout the country, each of which is to be modernized from every angle of efficiency. The foundry of the Milwaukee Works, Milwaukee, is being brought into condition for the production of a new tractor and a large investment but recently has been expended for new mechanical molding devices, conveyors and accessories. The malleable foundry department of the McCormick works, Chicago, has been rearranged and largely re-equipped.

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Passing of the Old Guard

GRADUALLY, under the press of changing conditions and in line with what is regarded as modern efficiency, many of the habits and customs, traditions and shop practices of the foundry are passing away. Whether this change really represents progress. in the proper sense of the term or simply is an indication of man's natural craving for variety, in some respects, is open to question. To a considerable extent the personal factor has been removed and the employes more and more are coming to be regarded as so many pieces of animated machinery. The craftsman who served a long apprenticeship under an exacting master and as a result was equipped with a well trained mind, a pair of hands, expert in wielding the tools of his chosen calling, with eyes accustomed to symmetry and proportion and with a physique capable of withstanding the somewhat severe exercise incident to foundry practice, was a man of the kind well capable of going through a day's work with a minimum of supervision.

He laid his pattern down on the board in the morning, or in many instances dug a pit in the foundry floor, mixed his own facing sand, instructed the carpenter how to fix his cope and if it was not ready in time, felt no reluctance in taking a hatchet and saw and doing his share in fitting the bars. He ordered his own chaplets from the blacksmith shop and cut them off with a hammer and chisel to suit requirements. He decided on his own initiative where to set his gates and risers and also whether he should roll his cope over or finish it overhead. If the mold was to be skin dried or dried in the oven, he knew how to mix his blacking and also how to apply it without knocking down every projecting point on the mold surface. Occasionally he used a little arithmetic in deciding the amount of weight required to hold down a cope, but more frequently he depended on intuition, instinct or, as he was more apt to term it, *judgment*. Even without any particularly concious effort on his part he had absorbed knowledge of that character, and he depended on the same source of information when calculating the amount of iron required to pour a casting. By a peculiar mental transition he could compare the volume of iron in the ladle with the volume of the pattern even if he didn't know the actual weight in pounds avoirdupois. He handled his own ladle and saw that his mold was poured fast or slow or a combination of both depending on its general character.

The wind was not *put on* until after every mold in the shop was ready for the iron even though in some cases it was apparent that several hours must elapse before the last mold possibly could be poured. The introduction of methods whereby the distribution and pouring of the iron were taken altogether out of the molder's hands may be regarded as the first step toward inaugurating present day conditions. In some instances this practice has been carried to a logical conclusion with the result that the foundry approximates closely the intensive manufacturing methods existing in any other line of industry. It is quite true that in many of the smaller shops particularly jobbing shops, the old order still obtains and the mechanics employed therein can turn their hand to any phase of foundry practice, but in general with all other types of all around mechanics, the all around molder is passing.

Trade Outlook in the Foundry Industry

BUSINESS is improving steadily in castings manufacturing lines. Practically every contributing factor is favorable for a continuation of the present foundry activity through the fall and well into the winter season. At present transportation and labor supply problems are much more perplexing to the foundryman than is the question of obtaining orders through the months to come. Shipments of iron, particularly from the southern furnaces, though improved during the past week, are occasioning concern, while in the larger centers, foundry labor is at a premium and wages are being advanced.

Auto Demand Continues

The advancing season has not yet shown a marked influence on the demand for automotive castings. Production figures of the department of commerce show that in August a total of 246,941 passenger automobiles and 24,064 trucks were manufactured. This shows an advance over the July count which recorded 224,057 passenger cars and 21,357 trucks, and places August second only to June in this phenomenal year. The total number of automobiles manufactured in the first eight months of this year is practically equal to the entire number produced in 1921. This importance of this industry as a casting consumer is evident at this time when the shortage of foundry labor is most strongly evident in the automobile manufacturing districts. September sales of passenger cars are reported as keeping pace with the previous month, reports for the first week of month showing a production 25 to 30 per cent. greater than the same period last year. Rural districts in particular are reported to be buying strongly. Difficulties in securing iron, particularly high silicon grades, have threatened operations of some automotive castings plants, but this situation is slowly adjusting itself under the more lenient restrictions upon the railway freight car supply.

Prices of Raw Material for Foundry Use

CORRECTED TO SEPT. 28

Iron		Scrap	
No. 2 Foundry, Valley	$32.00	Heavy melting steel, Valley	$22.00 to 22.50
No. 2 Southern, Birmingham	28.00 to 30.00	Heavy melting steel, Pitts	21.50 to 22.00
No. 2 Foundry, Chicago	32.00	Heavy melting steel, Chicago	18.50 to 19.00
No. 2 Foundry, Philadelphia	32.63 to 34.13	Stove plate, Chicago	19.75 to 20.25
No. 2 Foundry, Buffalo	32.00 to 34.00	No. 1 machy. cast, Chicago	24.00 to 24.50
Basic, Valley	34.00	No. 1 cast, Philadelphia	22.00 to 23.00
Basic, Buffalo	32.00 to 33.00	No. 1 cast, Birmingham	20.00 to 23.00
Malleable, Chicago	32.00	No. 1 cast, Buffalo	20.00
Malleable, Buffalo	32.00 to 34.00	Car wheels, iron, Pittsburgh	23.00 to 23.50
Coke		Car wheels, iron, Chicago	24.50 to 25.00
Connellsville foundry, coke	$12.00 to 13.00	Railroad malleable, Chicago	24.50 to 25.00
Wise county foundry, coke	13.00 to 13.50	Agricultural mal., Chicago	24.50 to 25.00
		Railroad malleable, Buffalo	19.00 to 19.50

Car Shortage Impends

Although the latter part of the month has seen a slight easing off in transportation difficulties which threatened the shipment of foundry materials, particularly pig iron, the increasing demand for cars is the object of some concern. Southern furnaces have been able to secure box cars in many cases where open top rolling stock was not available. Except where the customers employ yard cranes to unload their materials, this method of shipping is proving satisfactory. However, the surplus freight car totals have been steadily falling off, and the shortage reported is growing from week to week. Blast furnaces, particularly in the north, in some instances have been forced to pile iron for which there is an active demand, while the problem of obtaining a constant supply of coke has deterred some furnaces which have been down from blowing in. A shortage of high silicon iron has resulted from the latter condition, and prices are advancing steadily, some sales being reported as high as $45.50. Coke shipments to foundries have been interrupted but little, and the steady increase in the production of both coal and coke is expected to remove all apprehension on the score of fuel supplies. Shipments of sand are growing as the winter season approaches.

Railroads Buy Again

After a short period of inactivity, railroads are again buying both cars and locomotives. The total number of freight cars ordered during the week which ended Sept. 23 is reported to have been over 4500, while repair contracts are growing steadily. This is reflected strongly in the railway specialty foundries, where operations again approach capacity. This factor coupled with the demand for automotive castings is particularly noticeable in the malleable castings field, where the August rate of operation is said to have been about 64 per cent of normal. September probably will show a slight loss, but still will maintain a high mark. Building construction continues to supply a steady demand for castings. August contracts awarded showed a gain of 6.9 per cent over July, according to statistics from more than 150 cities, and the increase over August, 1921, is given as 38.2 per cent. The sales of bath tubs during the past month totaled 98,765 as compared to orders for 111,455 for July, according to statistics compiled by the department of commerce. Other sanitary ware also showed a slight decrease in the demand, but still maintained a high average for the closing season. Cast iron pipe sales are usually good for the time of year. Farm implement demand is increasing, while dealers are said to have moved their surplus stocks.

Brass Castings Active

Nonferrous foundries are sharing in the general advance. Plumbing goods are in demand, one firm which recently has completed a new addition, doubling its capacity, reports that it is sold up to the first of next year for its entire output. Brass and aluminum castings also are being contracted well into the winter by automobile builders. Prices on nonferrous metals based on New York quotations in the *Daily Metal Trade* for Sept. 28 follow: Casting copper, 13.40c to 13.50c; electrolytic copper, 13.87½c; Straits tin, 32.50c; lead, 6.62½c; antimony, 6.75c to 7.00c; aluminum, No. 12 alloy, producers' price, 19.00c to 19.20c, and open market, 17.00c to 18.00c. Zinc is 6.87½c, E. St. Louis, Ill.

Personal

John McCrane has accepted a position as foreman of the Empire Foundry Co., Port Chester, N. Y.

John P. Bachman has accepted a position as foreman with the Lodge Mfg. Co., South Pittsburgh, Tenn.

Clinton Somers, Battle Creek, Mich., has accepted a position as foreman with the South Haven Foundry & Machine Co., South Haven, Mich.

William H. Woodin, president of the American Car & Foundry Co., has been appointed fuel administrator of New York state.

Frank B. Worrilow, for the past five years superintendent of the Millbury Steel Foundry Co., Millbury, Mass., has resigned to become assistant superintendent of a foundry in Pittsburgh.

J. R. King, for a number of years superintendent of the Brillion Iron Works, Brillion, Wis., has accepted a like position with the Production Foundries, Ann Arbor, Mich.

David J. Martin, formerly associated with the Tabor Mfg. Co., Chicago, as salesman, is now foundry superintendent for Vulcan Foundry Co., Ambler, Pa.

William E. Matthews, Cleveland, has been elected president of the Carroll Foundry & Machine Co., Bucyrus, O. W. D. Jones, Galion, O., is the new vice president, and F. B. Squires, Cleveland, secretary and treasurer.

G. Harold Gilpatric, secretary and treasurer of the Putnam Foundry & Machine Co., Putnam, Conn., has been renominated by acclamation for state treasurer of Connecticut by the Republican state convention.

A. D. Neal, recently connected with the roll department of the Duquesne Steel Foundry Co., Pittsburgh, and formerly identified with the sales department of the Carnegie Steel Co., Homestead, Pa., has been added to the sales force of the Pittsburgh Rolls Corp., Pittsburgh.

H. T. Burrows, Appleton, Wis., has accepted the position of secretary of the Malleable Iron Range Co., Beaver Dam, Wis. Mr. Burrows is a tax expert, having for several years been connected with both the state and federal income tax bureaus, later joining the executive staff of the Fox River Valley Paper Co., Appleton.

E. D. Betts, formerly with Michigan Malleable Iron Co., and later with Stroh Castings Co., both of Detroit, Mich., and who was one of the original organizers of the Production Foundries Co., Ann Arbor, Mich., occupying the position of superintendent, has disposed of his interests in that company and is establishing himself as a consulting foundry engineer. Mr. Potts will retain his Ann Arbor residence.

Study Safety Problems

At the first meeting of the Pittsburgh Foundrymen's association following the summer vacation period, held Sept. 18 at the General Forbes hotel, Pittsburgh, John A. Oartel, chief of the safety bureau of the Carnegie Steel Co., delivered an address on "One Hundred Per Cent Safety in the Foundry." He asserted that approximately 90 per cent of the many thousands injured each year in industrial accidents are able to trace their condition to carelessness, indifference, or lack of instruction in safety. He stated that in many instances safety appliances provided by the management do no good because they are not used, due to lack of instruction.

This gathering witnessed the installation of the officers elected last spring, namely: President, Samuel B. Cuthbert of the Carnegie Steel Co., Braddock, Pa.; vice president, John W. Guay of the Union Steel Casting Co., Pittsburgh; and William J. Brant, re-elected secretary and treasurer.

It was announced at this gathering that in the period between January and April, 1923, a series of lectures will be presented to the members of the Pittsburgh Foundrymen's association under the auspices of the National Safety council.

Acquires New Foundry

The Detroit Foundry Co., Detroit, which specialize in motor cylinder blocks, has secured the foundry premises adjoining it, formerly occupied by the American Blower Co., which moved its foundry operations to Cincinnati, O. The new acquisition will be utilized as an addition to the company's present 65-ton capacity, enabling over 100-ton per day output.

Report Test on Chilled Iron Car Wheels

Thermal stresses in chilled iron car wheels were determined at the United States bureau of standards. The wheels were heated by passing an electric current through a band of iron encircling the wheel, and the resulting stresses were calculated from strain-gage measurements after correcting for thermal expansion. The maximum stresses developed were close to the tensile strength of the cast iron. The method used for testing and the results secured are reported in *Technological Paper No. 209* of the department of commerce by G. K. Burgess and R. W. Woodard. The following summary and conclusions are given.

A method has been described for electrically heating car wheels in the laboratory which produce effects similar to that encountered through long application of the brakes on heavy grades. Observations have been made of the strains resulting from such heating on wheels of various design and weight from three different manufacturers. The rate of heating was severe enough to crack many of the wheels, and the internal stresses in all cases approximated the ultimate tensile strength as shown by test specimens. The total number of wheels tested is too small to draw any definite conclusions, but the results seem to point to the following generalities, which should be confirmed by a greater number of tests: The method used was such that the heat input to the wheel was much greater than that which would enter a wheel doing its proportionate part in taking any car down any grade found on trunk-line railroads at a reasonable speed.

The rate of heating in the special thermal test as conducted by the bureau were more severe than actual service conditions, so that wheels which stand up under the foregoing tests will not fail under the extreme conditions of a long and heavy application of the brakes. These special thermal tests, however, are not as severe as the thermal test required by the M. C. B. specifications, in which for rejection a wheel must crack through the rim in two minutes. In the tests here reported no wheels cracked through the rims, although a large number developed cracks in the plates.

The maximum stresses developed are very close to the tensile strength of the cast iron and are some function of the strength of the iron.

Preliminary tests (not recorded herein) show that the stress in a tangential direction on the outer face and also the stress in both the radial and tangential direction on the bracket side of the wheel are relatively small when compared to those in a radial direction on the outer face of the wheel.

The maximum tensile stresses occur in a radial direction near the junction of the double plates in the M. C. B. or Washburn type of wheel. In the arch-plate type the maximum stress is somewhat nearer the hub.

This seems a desirable condition in manufacture.

By proper distribution of metal in the single-plate type of wheel there would appear to be a possibility of securing a wheel more capable of meeting service requirements.

With identical rates of heat input the heavier-weight wheels withstand the effect of tread heating with less strain than the lighter wheels. It seems conceivable, however, that a wheel may be made where increased weight will not aid the wheel to withstand brake application. Such weight, however, is beyond the weights in use today.

Show August Gain

Reports from 59 out of about 300 foundries which are included in the Ohio State Foundrymen's association showed a normal melt in August of approximately 72.2 as compared with 58 per cent for July. During July reports were received from 68 foundries. Operations have shown a continuous trend upward since January, 1922, when the actual melt was only 22 per cent of normal. The raw material question was troublesome during August. Stocks on hand declined to a lower level than in July.

The trade report for August may be summarized as follows:

		Tons	Per cent of normal melt
Normal melt		17,677	100.0
Actual melt		12,723.2	72.2
Pig iron received		6,428.95	36.4
Spot	1,338.2		
Contract	5,090.75		
Scrap iron received		2,764.75	15.7
No 1 machinery	1,337.75		
No. 1 railroad	397		
Miscellaneous	1,030		
Pig iron on hand Sept. 1		12,493.21	70.8
Scrap on hand Sept 1		3,702	21.0

The 59 foundries which sent in returns have a normal melt of 17,677 tons and actually melted 12,723.2 tons, the percentage being 72.2. Pig iron received during the month was 6428.95 tons of which 1338.2 tons was purchased in the spot market and 5090.75 tons was bought on contract. Scrap iron received totaled 2764.75 tons of which 1337.75 tons was No. 1 machinery, 397 tons No. 1 railroad and 1030 tons miscellaneous. Pig iron on hand on Sept. 1 was 12,493.21 tons and represented 70.8 per cent of the normal melt. Scrap on hand Sept. 1 was 3702 tons and was 21 per cent of the normal melt.

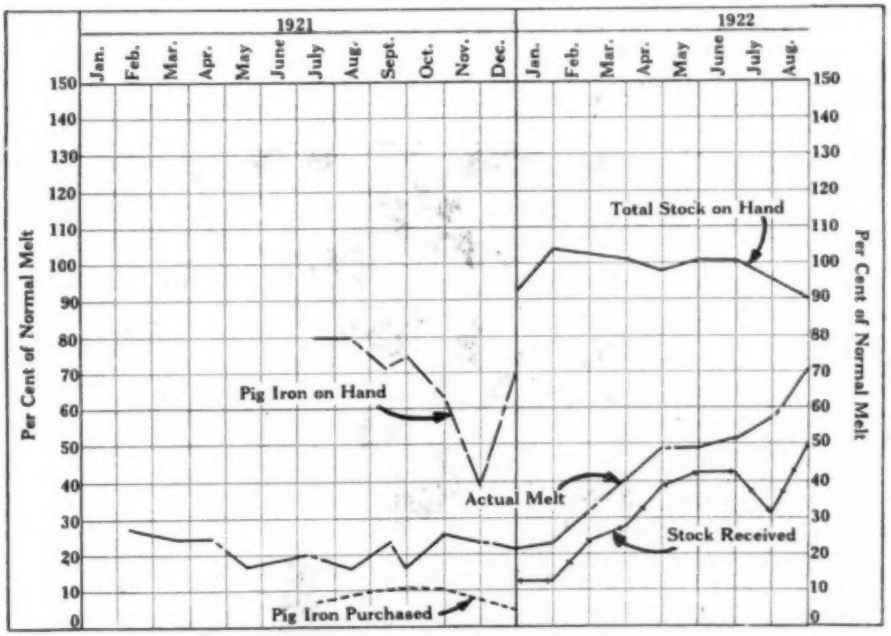
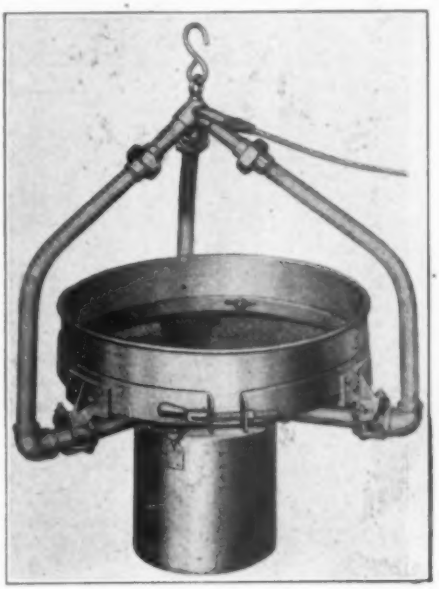


CHART SHOWING TREND OF MELT IN OHIO FOUNDRIES

Rapid Electric Sifter

Equaling the work of a dozen men sifting by hand, is the claim set up for the electrically operated riddle made by J. D. Wallace & Co., Chicago, and shown in the accompanying illustration. On actual test it is stated the machine can handle a ton of moist molding sand in four minutes through a No. 2 screen. On account of its light weight it may be suspended from any convenient support at any desired height and readily may be shifted by the molder either over his sand pile or over his flask or corebox. The device is equipped with a vertical motor in which the armature and shaft remain stationary and the field and housing revolve at high speed. The housing is weighted on one side and imparts an extremely rapid and regular vibratory motion similar to that of an eccentric flywheel. Direct connection of motor to riddle insures a minimum power consumption. No loss is caused by transmission or friction and the motor is equipped with specially designed ball bearings of the self-oiling type. The motor is enclosed in a dust-proof casing where cooling air is circulated. The air is drawn in at the top of one arm of the supporting frame tubing and after circulating around the motor is expelled at the top of a second arm. A valve trap at the air intake prevents the entrance of dust. The machine, as it is shipped, is provided with an 18-inch riddle frame carrying a No. 2 screen. This equipment readily may be changed to any other size by loosening the riddle clamps.

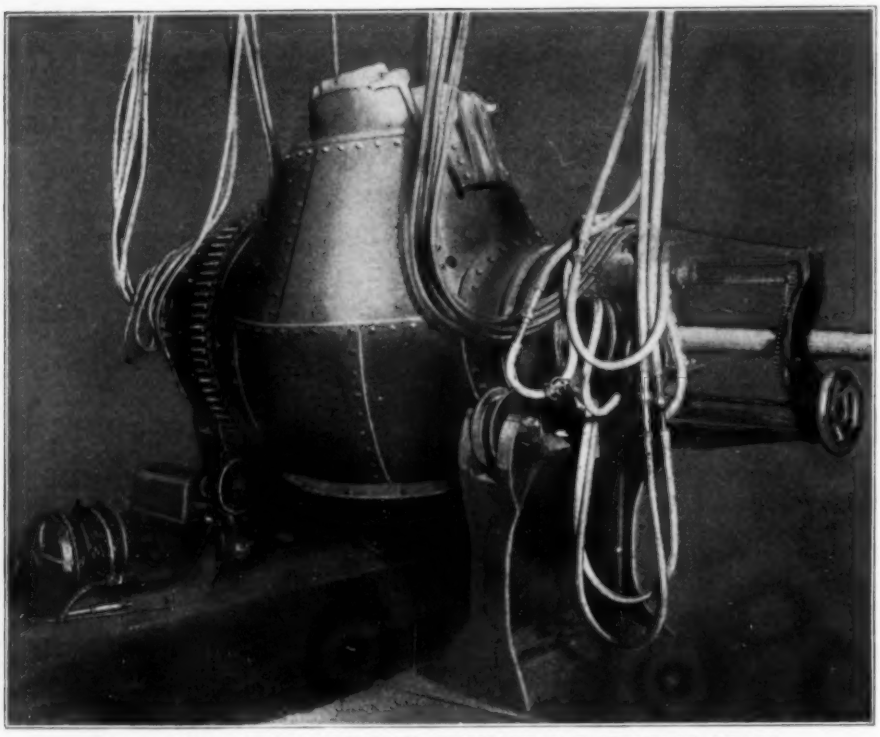


MOTOR IS ENCLOSED IN A DUST PROOF CASE UNDER THE RIDDLE

Suggest Preheating in Welding Cast Iron

To compensate for the lower melting point of cast iron as compared with steel, the Metal & Thermit Corp., New York, recommends that in preheating cast iron sections preparatory to thermit welding them, these sections be heated only a little more than necessary to show color, such as a dull red heat. If this advice is followed, it is claimed a more quiet pour will be obtained and the fusion will be just as perfect. This practice has now been tried successfully in numerous cases, the most important case being a thermit weld on a large cast iron press head which required 1100 pounds of thermit. The weld was perfect with good fusion to the extreme of the edge of the collar, although the cast iron section was heated only to a full red heat.

It is believed that this point is important and that operators will find it



NEW OSCILLATING ELECTRIC FURNACE FOR MELTING BRASS

will overcome possible difficulties which they may be experiencing in cast iron welding. It may be supposed that as the cast iron of the parts being welded is not quite so fully expanded at this lower temperature there might be a slightly greater tendency for hair line cracks to appear in the thermit steel collar perpendicular to the line of break.

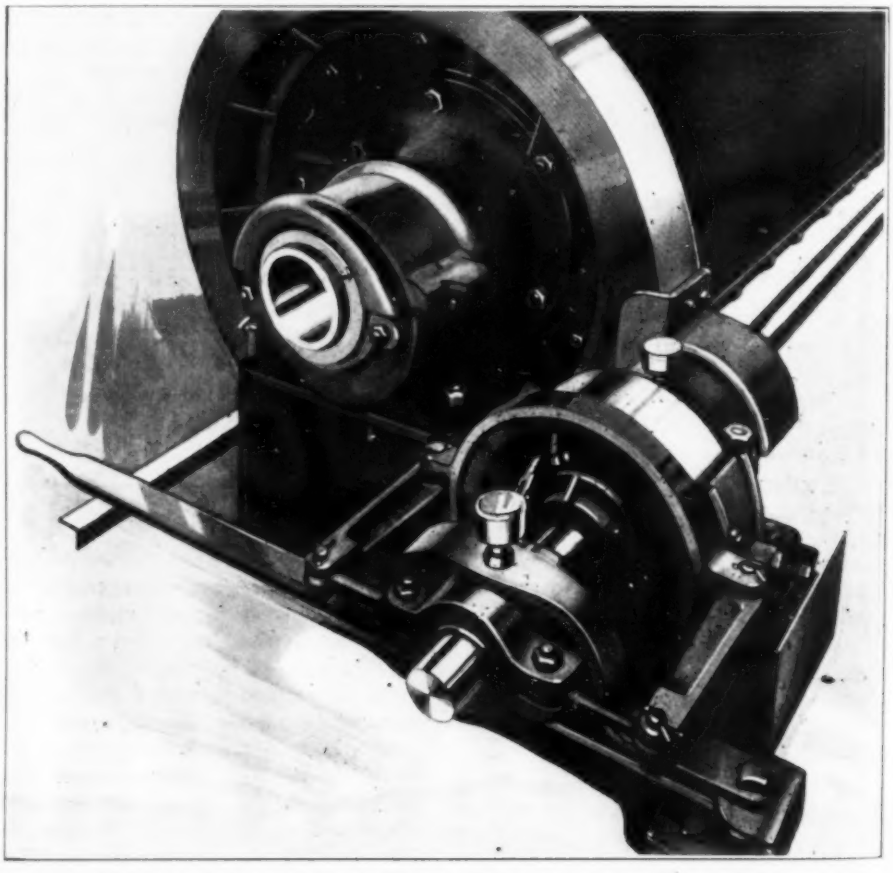
However, in actual practice, this has not been found to be the case, probably because the expansion curve is much greater up to a red heat than it is from the red heat to the white heat and that the sections practically are fully expanded at this dull red heat. It is also true that the thermit steel at first heats and expands the sections with which it comes in contact and, thus the slight difference in preheating is negligible.

Electric Furnace Shows Novel Features

Characteristics of the Hawley Electric oscillating brass melting furnace, handled by F. H. Niles & Co., Inc., Woolworth building, New York, include means of generating heat by an electric arc passing between two horizontal electrodes; a specially designed shell that permits pouring either into ladles or directly into the molds; the shape of the melting chamber permits the use of interlocking linings that hold tight to the shell; a mechanism arranged properly to oscillate the furnace during melting and also to tip it, complete with either automatic or hand control; a large door through which large pieces may be charged, and through which the furnace readily may be slagged. The furnace shown in the illustration is built in only one size, 1200 pounds capacity. Two other sizes are being designed and will be placed on the market in a short time, one of 600 pounds and the other of 2500 pounds capacity. All the necessary operating equipment is shipped with the furnace. The transformer is of sufficient size to furnish the current required to melt the entire charge of metal in approximately one hour. The lining consists of three courses of special refractories designed to effect high insulation as well as to prevent erosion and disintegration of the inner lining. Suitable electrodes and electrode cooling devices are incorporated in the furnace design together with means for adjusting the electrodes and thus regulating the current consumption.

Combination Clutch and Brake on Mill

A combination clutch and brake mechanism for tumbling mills to increase the safety of operation has been designed and patented by the Whiting Corp., Harvey, Ill. This simple device, as shown by the accompanying illustration, is controlled by a hand lever. Shifting this lever towards the mills engages the clutch and starts the mill. To stop the mill, the lever is moved in reverse direction, passing through neutral to the braking position. In this manner a loaded mill can be brought to rest at the desired point for unloading and without loss of time. The combination clutch and brake makes it impossible for the barrel to turn after the brake is set even though the barrel is unequally loaded.



COMBINATION CLUTCH AND BRAKE MAKES OPERATION SAFE

Inquiry for Equipment Grows

Increasing Demand for Foundry Machinery and Supplies Is Evident Through Increase in Interest During the Closing Weeks of September— Sales Reported Active in Small Sundries

INCREASES in the volume of inquiry for foundry equipment indicate that the soft spot in the market encountered during the early part of September has been passed. With continued activity in foundry operations and the growth in demand for replacements and small sundries, manufacturers confidently expect a steady improvement. The Barberton Machine & Foundry Co., recently incorporated, expects shortly to construct a foundry. James Singer is the engineer in charge. The Crucible Steel Castings Co., Cleveland, recently has contracted for annealing furnaces, core and mold ovens, and air and oil circulating systems with F. J. Ryan & Co., Philadelphia. Peck, Stow & Wilcox Co., Cleveland, Sill Stove Works, Rochester, and the H. B. Smith Co., Westfield, Mass., recently have purchased sand-blast equipment from the Pangborn Corp., Hagerstown, Md. The United States Cast Iron Pipe & Foundry Co., recently ordered a Newton type cupola from the Northern Engineering Works, Detroit. Other sales of the same firm include a 10-ton crane for the Center Foundry Co., Wheeling, W. Va. The Madison Foundry Co., Cleveland, has contracted for oven heating equipment to be added to existing core ovens by the Mayor Fuel Saving Furnace Co., Cleveland.

Small Purchases Predominate in Pittsburgh

UNFILLED orders on the books of foundry equipment sellers in the Pittsburgh district are fairly large, particularly for miscellaneous lots of the smaller items such as electric sand sifters, vibrators, ladles and ladle driers, flasks, riddles, etc. The Keystone Bronze Co. and the United States Sanitary Mfg. Co. were recent purchasers of flasks and the Westinghouse Airbrake Co., Wilmerding, Pa., also ordered several. Perhaps the largest item before the trade is a complete foundry installation for a steel foundry in Alabama which involves 20 or more large and small molding machines as well as considerable other equipment. While the major portion of September was quiet from a sales standpoint among molding machine manufacturers, inquiries were heavy, particularly during the third week. Sales of pleasing proportions are about to be consummated. Recent buyers of rollover molding machines from the Herman Pneumatic Machine Co. for making car wheels, include the Brown Car Wheel Co., Buffalo, and the National Car Wheel Co., Rochester, N. Y. The Herman company has completed shipment of the machines purchased some time ago by the Keystone Driller Co., Beaver Falls, Pa. A foundry located in the South Side, Pittsburgh, has just closed on a 5-ton cupola, and one or two other cupola inquiries from users in that territory still are pending. One seller disposed of a used Osborn jolt molding machine and is working on an inquiry for a sand cutter and a punch press. Frequent inquiries for grinding machines for foundries are received, the latest one being for a portable grinder by a Pittsburgh user. In addition to a 10-ton 3-motor electric traveling crane with 45-foot 6½-inch span purchased from the Northern Engineering Works, Detroit, the Centre Foundry & Machine Co., Warwood, W. Va., closed on one each 66 and 84-inch cupolas with the same manufacturer. The Centre company likewise bought a Greene blower and is understood to be planning early expenditures for core ovens, etc. The Babcock & Wilcox Co., Barberton, O., through the Pittsburgh office of Manning, Maxwell & Moore, Inc., closed on a 50-ton electric crane. Several hoist sales to nearby foundries likewise are noted by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.

Chicago District Demand Grows

EVERY indication in the foundry equipment market is that foundries are becoming more active and that good business may be expected through the fall. One indication along this line is the change in demand from hand power cranes to electric cranes, and also in the steady and increased demand for ladles. Coreroom equipment is being sold more readily during the past 30 days than for a long time previously. In molding machines, most business is for single machines of various types and no selling of large lots has been done recently. The Pullman Co. has been buying equipment for its car wheel foundry at Pullman, Ill., having placed a 120-inch cupola with the Whiting Corp., Harvey, Ill., and two sand mixers with the National Engineering Co., Chicago. One of these is equipped with a loading device. Dodge Bros., Detroit, have bought two 90-inch cupolas from the Whiting Corp. This interest has sold two 30 x 48-inch tumbling barrels to A. A. Wickland & Co., engineers, Chicago, a 5-ton electric crane to the Abrasive Co. of Canada, Hamilton, Ont., a 10-ton hand-power crane to the Missouri, Kansas & Texas railroad, a 15-ton hand-power crane to the Sessions Engineering Co., Chicago, and a 3-cubic-yard bucket crane to the Lehigh Portland Cement Co., Allentown, Pa. The National Engineering Co. in addition to the two Pullman mixers, has recently shipped one mixer with loading device to Cleveland, one to Ludington, Mich., and several to various users in the east.

Interest Lags in the East

BUSINESS in foundry equipment in the New York district is of a spotty character. Around the middle of September fair buying was done, but since then the volume has been smaller. A feature of the period is the considerable amount of business involved in the rebuilding of molding machines. The American Foundry Equipment Co. reports having received orders for rebuilding machines for the Nute, McGee & Cleary Co., Chambersburg, Pa., the Reading Foundry Supply Co., Reading, Pa., the Burnside Steel Co., Chicago, and the Toledo Steel Castings Co., Toledo. This company also reports having booked orders for sand cutting machines from the Packard Motor Car Co., Detroit, the Pullman Co., Chicago, and for two particularly heavy units from the Erie Malleable Iron Co., Erie. Flask makers report a heavy demand for aluminum snap flasks in the eastern territory. Electric furnace manufacturers do not report any outstanding business in that territory, but say a good many prospects appear to be reaching the closing stage. The report that the Farrel Foundry & Machine Co., Ansonia, Conn., had closed on steel for the construction of a foundry is in error. This company has contracted only for structural material for a crane runway.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The Elgin Stove & Oven Co., Elgin, Ill., plans the erection of a plant building.

The Norman Bronze Co., 100-12 Provost street, Brooklyn, N. Y., has plans for the erection of a 1-story foundry building addition.

Hilles & Jones Co., Wilmington, Del., has awarded a contract for the erection of a foundry building, 2-stories, 88 x 240 feet.

The Auburn Brass Foundry, Cranston, R. I., recently was organized by Axel W. Bergman and William Bergman, Providence, R. I.

Erection of an addition to its plant to be 25 x 35 feet, is planned by the Marsh Valve Co., Fourth and Brighan roads, Dunkirk, N. Y.

The C. F. Braun Co., 604 Mission street, San Francisco, manufacturer of heating equipment, plans the erection of a 1-story foundry building at Shorb, Cal.

The American Brake Shoe & Foundry Co., 30 Church street, New York, has purchased 17 acres at Portsmouth, Va., as a site for a new works.

The National Castings, Ltd., Belleville, Ont., is erecting an addition to its plant and installing some additional equipment including an electric furnace.

Capitalized at $10,000 the Cincinnati Valve Co., Cincinnati, recently was incorporated by Frank H. Grothaus, I. B. Gilbert, G. A. Ross, Thomas F. Bickett and E. Miller.

The capital stock of H. A. Poppert & Son, Inc., 421 Third street, Milwaukee, manufacturers of patterns, dies, die castings, etc., recently was increased from $100,000 to $150,000.

The Snapp Foundry, Inc., Winchester, Va., recently was incorporated with a capital stock of $50,000 by M. E. Robinson, C. A. Robinson, and others.

The Hummel Electric Steel Foundry Co., Conshohocken, Pa., has acquired the plant and business of the Conshohocken Electric Steel Foundry, which it will continue as a branch works. Improvements are under consideration.

The Thomas Pump Works, New York, recently was incorporated with a capital stock of $20,000 by G. W. O'Dell, J. J. Lang and Z. J. Greenspan. The company is represented by H. G. Fromberg, 320 Broadway, New York.

The Center Foundry & Machine Co., Wheeling, W. Va., plans the erection of a foundry building. It recently purchased an electric traveling crane from the Northern Engineering Works, Detroit.

The International Sand Blasting Co., New York, recently was incorporated with a capital stock of $10,000 by G. Estelman, G. Munz and J. Carrannante. The company is represented by D. Leavenworth, 29 Broadway, New York.

The Pullman Foundry Co., Pullman, Ill., shortly will start work on the erection of a foundry building, 1-story, 300 x 500 feet. Plans for the building have been completed by Frank D. Chase, Inc., Chicago.

The Laetz Foundry Co., Bay City, Mich., plans to move into its new plant shortly, which now is nearing completion. It will be utilized for the production of a general line of metal castings.

The Ideal Mfg. Co., care of the Delaware Charter Co., 904 Market street, Wilmington, D. I., recently was incorporated under Delaware laws with a capital stock of $80,000 to manufacture iron, brass, bronze and other metal castings.

The Stroh Steel-Hardening Process Co., Westinghouse building, Pittsburgh, is completing plans for the erection of an addition to its steel foundry at Ridge avenue and Chateau street. W. Y. Stroh is president of the company.

Capitalized at $100,000 the Bronze Hardware Mfg. Co., Buffalo, recently was incorporated by W. H. and E. K. Barlow and W. O. Kuhn. The company is represented by D. E. Hart, attorney.

The Stringer Bros. Foundry Co., 109 North Dearborn street, Chicago, manufacturer of cast iron plumbing products, has started work on the erection of an addition to its plant at Gadsden, Ala.

A charter has been granted to the Acme Brass & Metal Works, Inc., Waupaca, Wis., incorporated with $75,000 capital stock to manufacture and deal in metal products. The incorporators are Louis Larsen, B. C. Koepke and J. M. Braun.

Capitalized at $200,000 the Bridgeport Bronze Co., Bridgeport, Conn., recently was incorporated to manufacture bronze, brass and other metal products, y H. M. Trainor, H. L. Shaff and Jonathan Grout, 886 Main street, Bridgeport.

The Fraher Brass Works, Inc., 14 South Jefferson street, Chicago, recently was incorporated with a capital stock of $10,000 to manufacture brass, bronze and kindred metal products. Incorporators of the company are L. L. Richmond, Lowell A. Lawson and Thomas T. Dudley Jr.

The Codde Brass & Aluminum Co., 1006-7 Hammond building, Detroit, recently was incorporated with a capital stock of $30,000 to manufacture brass, aluminum, bronze and other metal products. The incorporators are Mayer C. Brown and Harry A. Codde.

The Nekoosa Iron Works, Nekoosa, Wis., founder and machinist, has let the general contract to Manske & Henry, Wood building, Wisconsin Rapids, Wis., for the erection of a 1-story plant addition, 36 75 feet. M. J. Powers is president of the company.

The Birmingham Stove & Range Co., Birmingham, Ala., has preliminary plans for the construction of an addition to its plant. A new department will be installed for the manufacture of gas ranges. B. H. Hartsfield is general manager of the company.

The Globe Malleable Iron & Steel Co., 101 Greenway avenue, Syracuse, N. Y., is planning the erection of an addition to its plant to be used for the manufacture of oil-operated engines and parts. H. E. Elmer is treasurer and general manager of the company.

The Portsmouth Stove & Range Co., Portsmouth, O., has let the contract to Jones & Lallow, contractors, for the erection of an addition to its foundry. This structure will enable the company to double its present castings production.

The Milne Foundry Co., Schenectady, N. Y., care of L. W. Block, Albany, N. Y., representative, recently was incorporated with a capital stock of $100,000 to manufacture iron, steel and other metal castings. Incorporators are W. H. Milne, J. E. Laurie and G. C. Ratchford, all of Schenectady, N. Y.

The Progressive Foundry Co., Rochester, N. Y., care of Crittenden & Crittenden, Power building, representatives, recently was incorporated with a capital stock of $100,000 to manufacture iron, steel and other metal castings. The incorporators of the company include P. Bittner, C. Bennett and C. Hobbing.

Stephen & Wolff, Inc., Buchanan and Loomis streets, Rockford, Ill., recently incorporated with a capital stock of $25,000, has taken over the former business of Stephen & Wolff and is leasing a sma foundry for the manufacture of dental flasks, articulators, bolts for dental flasks, and a general line of brass, bronze, aluminum and white metal castings. The company is understood to be in the market for some machinery.

The Seaboard Brass & Copper Co., 805 Continental building, Baltimore, recently was incorporated with a capital stock of $100,000 to manufacture brass, bronze, copper and kindred products. The incorporators of the company are Harvey H. Wilson, Edwin M. Talbot and Herbert Langrall.

The Somerton Foundries Corp., Philadelphia, care of the Capital Trust Co. of Delaware, Dover, Del., representative, recently was incorporated under the laws of Delaware with a capital stock of $250,000 to manufacture iron, steel and other metal castings. The incorporators are M. F. Devine and S. R. Kerr of Philadelphia, and C. L. Hadgkiss, of Camden, N. J.

High grade steel castings, made by the electric furnace process, will be manufactured by the Morristown Electric Steel Foundry, 106 Water street, Morristown, N. J., which recently was incorporated under the laws of New Jersey. The company will specialize in small castings. Officers are: President, S. B. Illingworth; vice president and works manager, Richard H. Eurich, and secretary-treasurer, J. Lovel Paulmier.

Dissolution of the co-partnership of Benjamin F. Klein and William J. Schoenberger as the United Brass Mfg. Co., 3844 Hamilton avenue, Cleveland, has been followed by Mr. Klein's continuation of the company for the manufacture of plumbing and water works brass goods and the organization by Mr. Schoenberger of the W. J. Schoenberger Co. with headquarters at Harvard avenue and East 103rd street, Cleveland. Mr. Schoenberger has taken over the gas valve and stove cock department of the United Brass Mfg. Co. and will manufacture gas valves, gas cocks and special fittings for gas appliances.

New Trade Publicaitons

CRANES—Various types of light cranes including jib cranes, underbraced jib cranes, pillar and pillar jib cranes, and truck and stacking cranes are described in bulletin No. 524, published recently by the Northern Engineering Works, Detroit. Each particular type is shown in illustration. In all some 19 types are represented.

MORTISER—A power feed vertical hollow chisel mortiser is described and illustrated in a 4-page illustrated bulletin being circulated by the Oliver Machinery Co., Grand Rapids, Mich. This mortiser will handle chisels from ¼-inch to ¾-inch square. Stroke is adjustable from 2½ inches to 4 inches long. Stock 6 inches wide can be centered beneath the chisel. Hollow chisels with 4-inch blades will mortise in 12-inch high material; chisels with 2¾-inch blades are commonly used in ¼-inch and 5/16-inch sizes. The column is a rigid, hollow, box type, one piece casting having a wide flanged floor support. It encloses the power feed mechanism with the exception of the drive pulley. The ways for the chisel carriage and for the table are planed at one setting to insure accurate alignment.